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THE VARIATION IN ANNUAL EGG PRODUCTION ACCORDING TO THE DATE LAYING COMMENCES.*†

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The reports of the Canadian Egg Laying Contests and the Canadian Record of Performance show that certain breeders have developed their flocks to a high standard of egg production. While the individual flocks having a high average egg production are not confined to any one breed, or to any particular locality, the average total egg production varies considerably in the different parts of the country. Little is known concerning the total and monthly egg production for a single breed under different climatic conditions. The value of having such data to serve as a guide to indicate future production has been pointed out by Asmundson (*2*). In addition it would be desirable to know what variation exists in the factors which are known to influence egg production.

The number of eggs which a hen will lay during her first year is determined to some extent by the date of her first egg. The relation of the date of sexual maturity to the subsequent egg production has been shown by Kempster (*7*), who concludes that early layers make the best winter and annual records. Kempster, working with S. C. White Leghorns, finds that the optimum date of sexual maturity is approximately November 1, that there is a perceptible correlation between the date of sexual maturity and the summer egg production, and that little correlation exists between the date of sexual maturity and the rate of laying. Jull (*6*), using Barred Plymouth Rocks, found that the birds which commenced laying in October had the highest annual production and the greatest rate of production during the season of high prices. Jull suggests that data concerning the distribution of birds according to the date of their first egg, and their subsequent annual egg production in various parts of the country, should aid in determining the optimum date for the commencement of laying contests.

The object of this paper is to present data concerning the relation of the month laying commences to the annual egg production and the egg weight of a single breed kept in different parts of the country.

THE SOURCE OF THE DATA

The data used in this study were taken from the annual egg production records of 5324 Barred Plymouth Rock pullets trapnested under the

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Canadian Record of Performance plan during the years 1923-24, 1924-25 and 1925-26. The records of Barred Plymouth Rock pullets were selected because only in this breed was it possible to find entries from all the provinces of Canada. The birds whose records were used were trapnested in the flocks of 80 different breeders. The distribution of these breeders, and the number of birds by provinces is shown in Table 1.

TABLE 1.

	P.E.I.	N.S.	N.B.	QUE.	ONT.	MAN.	SASK.	ALTA.	B.C.	TOTAL
Number of Breeders	2	4	7	12	22	7	4	6	16	80
Number of Birds	139	111	590	655	1439	449	190	478	1273	5324

THE RECORDS USED AND THE METHODS OF CLASSIFICATION

The records of only those birds which started to lay after they were officially banded, and which remained in the Record of Performance until the end of their laying year, were used. Consequently this study does not include the records of birds which were laying when banded, which died, or which were withdrawn. A complete summary of the total entry, the mortality, the withdrawals and the number of certificates issued for the period under consideration is given in Reports 5, 6 and 7 of the Canadian Record of Performance (*3*).

The annual egg production includes all eggs laid in the trap-nests during a twelve-month period commencing on the date of laying of the first egg. Under the rules of the Canadian Record of Performance, a bird's record "may commence from the date a bird (after being officially banded) lays her first egg in the trapnest on or after July 1 and on or before December 31. In the event of a bird commencing to lay after December 31 the record period shall date from January 1. No records will run after November 30." Of the birds included in this study which started to lay after January 1, and consequently did not have a full twelve-month laying period, comparatively few continued laying after November 30 so that the constants secured should not be materially affected.

The records were classified for each year and province separately according to the month laying commenced. For the study of annual egg production the records were grouped in twenty-egg classes with a range from 1 to 300 eggs. Five birds which laid over 300 eggs were placed in the 281-300 egg class.

The constants (mean, standard deviation and coefficients of variability) were calculated by the usual formulae.

DISTRIBUTION OF BIRDS

The distribution of birds according to the month laying commenced for each province is given in Table 2. It can be seen that in some of the provinces the total number of birds whose records were available is not large. However, as each group presents a fairly wide range of annual egg production it is believed that the birds in any one group are a fair sample of the Barred Plymouth Rocks bred and raised for egg production.

TABLE 2.

Month laying commenced	P.E.I.	N.S.	N.B.	QUE.	ONT.	MAN.	SASK.	ALTA.	B.C.	TOTAL
September			44	16	79	15	5	45	99	303
October		55	64	191	181	31	29	103	173	777
November	20	13	213	243	404	129	53	135	343	1553
December	35	67	174	117	489	136	72	116	371	1577
January	41	26	67	51	209	96	27	52	218	787
February	43		28	37	77	42	4	27	69	327
Total	139	111	590	655	1439	419	190	478	1273	5324

The distribution given in Table 2 shows that certain provinces differ considerably as to the time when the majority of the birds commence to lay. In the provinces of Prince Edward Island and Nova Scotia the majority of the birds commence to lay much later than in any of the other provinces. In these two provinces most of the birds in this study started to lay after December 1. In all of the other provinces more than fifty per cent of the birds were laying by December 1.

With the exception of Prince Edward Island and Nova Scotia, the distribution of the birds by months for any one of the remaining seven provinces, and the total for all Canada, is quite uniform, with the peak coming in either November or December. In these seven provinces the majority of the birds commenced to lay in November and December.

The distribution expressed in percentages according to the month laying commenced for all the birds is as follows: September 5.7 per cent, October 14.6 per cent, November 29.1 per cent, December 29.6 per cent, January 14.9 per cent and February 6.1 per cent.

ANNUAL EGG PRODUCTION

The mean annual egg productions for the separate years are given in Table 3. There was a considerable increase each year in the number of Barred Plymouth Rocks which completed their year in the Record of Performance. The mean egg productions for the years 1923-24 and 1924-25 are approximately the same. In 1925-26 there was a definite increase of 4.38 $\pm$0.304 eggs per bird over the preceding year. The mean egg production per bird for all years (170.31 $\pm$ 0.416 eggs) is higher than that reported by Dunn (*4*) for Barred Plymouth Rocks in the Storrs contest and also slightly higher than the averages reported by Elford and Taylor (*5*) for the Barred Plymouth Rocks in all the Canadian Contests for the years 1922-23 and 1923-24.

TABLE 3.—*Variation constants for annual production by years.*

Year	Number of Birds	Mean Annual Production	Difference	Standard Deviation	Coefficient of Variability
1923–24	1336	168.96$\pm$0.843		45.75$\pm$0.596	27.07$\pm$0.352
1924–25	1750	168.78$\pm$0.726	0.18$\pm$1.112	45.09$\pm$0.513	25.71$\pm$0.292
1925–26	2238	173.16$\pm$0.633	4.38$\pm$0.304	44.44$\pm$0.447	25.66$\pm$0.258
Total	5324	170.31$\pm$0.416		45.04$\pm$0.294	26.44$\pm$0.173

There was practically no change in either the absolute or relative variability from year to year. The variation constants agree quite closely with those of the Barred Plymouth Rock contest records studied by Dunn (*4*). The relative variability for annual egg production is somewhat higher than

that found by Asmundson for S.C. White Leghorns and Rhode Island Reds in British Columbia (*1*), (*2*).

The variation constants for annual egg production for each province are given in Table 4. The provinces are listed in sequence according to their mean egg productions. The means have a range from 157.44 ± 1.095 eggs in Quebec to 187.86 ± 0.818 eggs in British Columbia. British Columbia shows a significantly higher mean than any of the other provinces. Nova Scotia and Manitoba have approximately the same means. The means for Saskatchewan, Alberta, New Brunswick and Ontario lie between 163 and 168 eggs per bird. Prince Edward Island and Quebec have lower means, but the difference of either mean from the mean of any one of the provinces in the preceding group is hardly significant.

TABLE 4.—*Variation constants for annual production by provinces.*

Province	Number of Birds	Mean Annual Production	Difference	Standard Deviation	Coefficient of Variability
British Columbia	1273	187.86±0.818		43.32±0.578	23.05±0.307
Nova Scotia	111	177.56±2.418	10.30±2.552	37.78±1.711	21.27±0.963
Manitoba	449	176.28±1.377	1.12±2.782	43.26±0.973	24.54±0.552
Saskatchewan	190	167.38±1.781	8.90±2.250	36.40±1.259	21.69±0.750
Alberta	478	166.22±1.472	1.16±2.310	44.16±1.041	26.56±0.625
New Brunswick	590	165.56±1.101	0.66±1.837	39.65±0.778	23.94±0.469
Ontario	1439	163.16±0.852	2.40±1.391	47.96±0.607	29.39±0.372
Prince Edward Island	139	158.20±2.320	4.96±2.471	40.54±1.639	25.82±1.036
Quebec	655	157.44±1.095	0.76±2.565	41.56±0.714	26.41±0.492
Total	5324	170.31±0.416		45.04±0.294	26.44±0.173

There are slight differences among the provinces as to variability of the birds. The range of the standard deviation is from 36.40 ± 1.259 eggs in Saskatchewan to 47.96 ± 0.607 eggs in Ontario. The relative variability as measured by the coefficient of variability varies from 21.27 ± 0.963 per cent in Nova Scotia to 29.39 ± 0.372 per cent in Ontario. The differences in the variability of the birds do not appear to be correlated in any way with the differences in the means.

The data presented in Table 5 give the mean annual egg productions for each monthly group of birds by provinces, and the total for all the birds. In nearly every province the mean egg productions of the September, October and November groups are much greater than those of the December, January and February groups. In all the provinces except Prince Edward Island, Nova Scotia and Saskatchewan the decrease in mean egg production from the November group to the December group is statistically significant.

TABLE 5.—*Mean annual egg production.*

Month	P.E.I.	N. S.	N. B.	Que.	Ont.
Sept.			173.18±3.804	155.00±7.805	157.60±3.411
Oct.		194.00±10.400	176.25±2.901	167.48±2.165	171.10±2.377
Nov.	174.00±6.276	186.40± 5.623	174.22±1.825	163.08±1.656	178.50±1.265
Dec.	160.84±5.099	181.06± 2.691	164.24±1.956	145.06±2.181	162.48±1.477
Jan.	164.62±3.574	156.92± 5.035	136.58±2.707	148.04±4.708	145.60±2.057
Feb.	144.04±3.986		134.46±2.835	121.88±4.042	127.68±2.691
Total	158.20±2.320	177.56± 2.418	165.56±1.101	157.44±1.095	163.16±0.852

Month	Man.	Sask.	Alta.	B.C.	All Birds
Sept.	206.00±6.385	142.00± 6.164	188.22±4.694	205.76±2.893	182.82±1.831
Oct.	179.04±5.112	174.82± 4.087	181.44±2.798	212.76±2.033	180.34±1.137
Nov.	194.64±2.066	172.64± 3.277	178.80±2.348	197.40±1.346	180.38±0.727
Dec.	177.34±2.472	167.78± 2.735	151.88±2.617	183.86±1.387	167.88±0.752
Jan.	161.68±2.573	146.30± 4.849	143.38±3.969	163.96±1.641	153.80±0.974
Feb.	137.16±3.928	140.00± 3.372	117.40±4.250	146.24±2.686	134.70±1.342
Total	176.28±1.377	167.38± 1.781	166.22±1.472	187.96±0.818	170.31±0.416

A comparison of the means of the September, October and November groups shows that there are slight differences present in each province. The differences among these groups in Nova Scotia, New Brunswick, Quebec and Alberta are not significant. In Ontario the birds which commenced to lay in November had the highest mean egg production. The September group in Manitoba shows a very high mean. It is believed that this is due to the presence in this group of a highly selected flock of birds. The November group would have the highest mean egg production if the records of this particular flock were not included in the study. In British Columbia the mean egg production was highest for the October group, with the September group second and the November group third. The differences of one group from another in Ontario, Manitoba and British Columbia are significant.

The mean egg productions for all the birds show clearly the large difference in eggs between the birds in this study which started to lay before November 30, and those which started to lay after December 1. The drop from 180.38 ± 0.727 to 167.88 ± 0.752 eggs per bird is quite significant. The differences between the September and October groups and the October and November groups are not significant.

EGG WEIGHT

Under the Record of Performance inspection system provision is made whereby sufficient eggs are weighed to determine whether a hen's eggs are, on the average for the year, above (plus) or below (minus) two ounces.

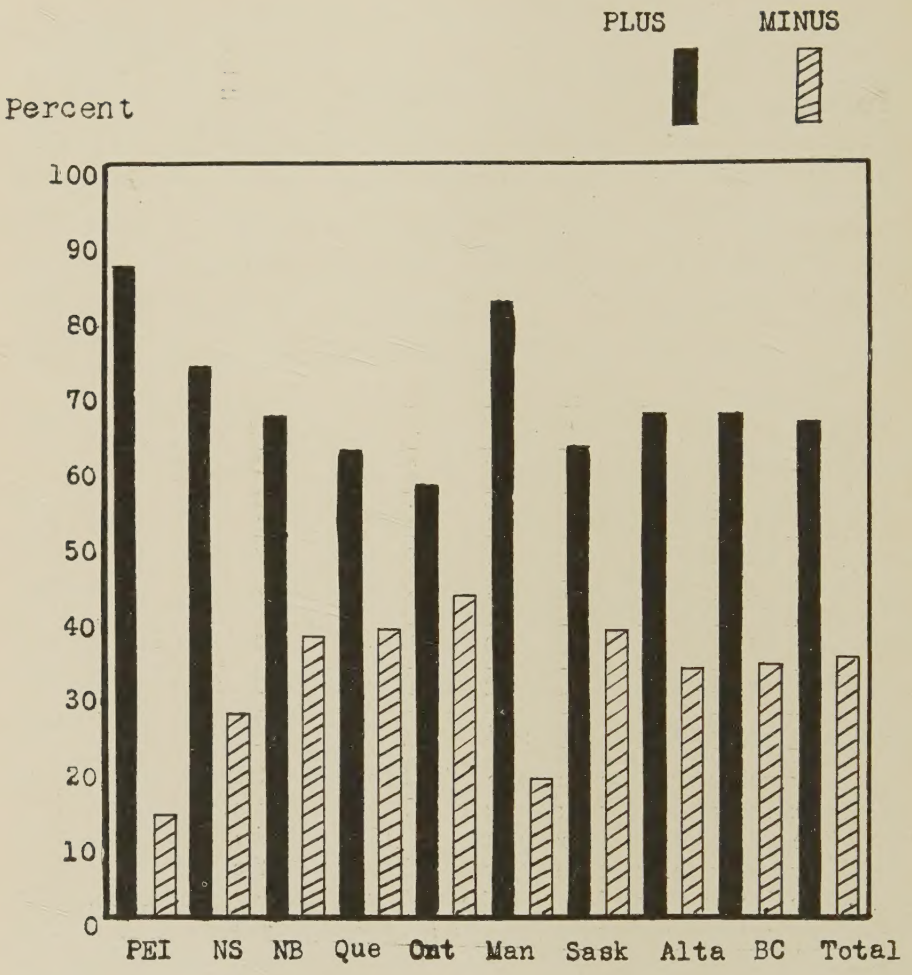

FIGURE 1. Showing the percentages of birds laying eggs over and under two ounces for each province.

Since this information was available in the records used in this study, Figures 1 and 2 have been prepared to show the percentages of plus and minus birds.

Figure 1 gives the percentages of plus and minus birds for each of the nine provinces. A considerable variation in egg weight exists in this group of Barred Plymouth Rocks among the various provinces. In every province the percentage of birds laying plus eggs exceeds by a fair margin the percentage of birds laying minus eggs.

In regard to the relation of the date laying commences to the egg weight the opinion prevails that the birds starting to lay early lay small eggs. The data presented in Figure 2 bear out this opinion to a certain extent. The percentage of birds laying minus eggs is greatest for the September group, and this percentage decreases with each monthly group up to January. While the percentage of birds laying minus eggs among

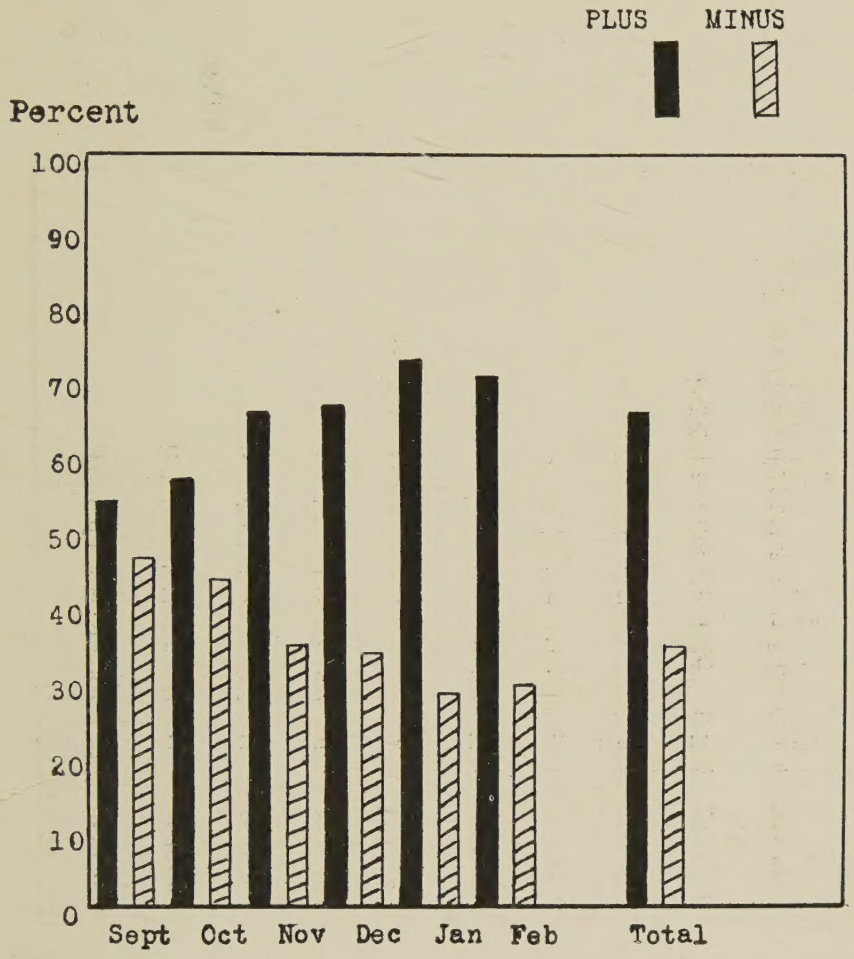

FIGURE 2. Showing the percentages of birds laying eggs over and under two ounces according to month laying commenced.

the early starters is quite high the majority of these birds laid eggs which averaged over two ounces. Of the total number of birds 65.3 per cent laid plus eggs and 34.7 per cent laid minus eggs.

SUMMARY

1. The majority of the birds whose records are used in this study started to lay in November and December.
2. The birds in Prince Edward Island and Nova Scotia commenced much later than the birds in the other provinces.
3. British Columbia, Ontario and Quebec had the largest number of early layers.
4. The mean annual egg production of all the birds was 170.31 $\pm$ 0.416 eggs.
5. The highest mean annual egg production for a separate province was 187.86 $\pm$ 0.818 eggs for British Columbia and the lowest 157.44 $\pm$ 1.095 eggs for Quebec.

6. There were in some cases distinct differences in the mean egg productions according to the month laying commenced. This was most evident in Prince Edward Island, Ontario, Manitoba and British Columbia.
7. The relative percentages of birds laying eggs over or under two ounces varied widely in the different provinces.
8. The percentage of birds laying eggs under two ounces was greatest for those starting to lay in September (46 per cent) and the least for those starting to lay in January (28 per cent).

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NEW PHYSIOLOGIC FORMS OF *PUCCINIA GRAMINIS TRITICI**

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In 1917 Stakman (*9*) announced the discovery of physiological specialization in stem rust of wheat, and in 1922 he and Levine (*10*) published an analytical key to forms of rust isolated by them. All forms of rust collected in Canada up to 1926 were identified as one or other of the forms found in the United States. Since that year a number of forms different from those described by Stakman and Levine† have been isolated in Canada (*8*).

With the establishment of the Dominion Rust Research Laboratory at Winnipeg, Manitoba, in 1925, facilities were afforded for stem rust research in Canada on a more adequate scale than had hitherto been provided. Collections of wheat stem rust had been made in the three western provinces, Manitoba, Saskatchewan and Alberta, for six successive years, and seventeen physiologic forms of stem rust had been isolated, (*3,4,5*) but it was not until 1926 that a systematic search for physiologic forms was begun in all the provinces of the Dominion. As a consequence of this endeavour, the number of collections made annually was greatly increased, and the possibility of discovering new forms of rust enhanced.

The collections were made, for the most part, during the annual rust survey which is carried on by the laboratory. In this survey the Universities of Manitoba, Saskatchewan and Alberta and the various Dominion Experimental Farms and Stations coöperated. As wide a variety of hosts as possible was included in these collections in order that a comprehensive idea of the physiologic forms occuring in the country might be obtained. These hosts included many varieties of wheat, barley, and as many of the wild grasses as were found infected with wheat stem rust.

Owing to repeated and severe losses from rust, many farmers, particularly in Manitoba and southern Saskatchewan, began to grow varieties of durum and of the recently-introduced common wheat. Greenhouse experiments had indicated that some of these were susceptible to certain physiologic forms to which Marquis was resistant (*6*). It seemed possible, therefore, that some forms which had not been able to live upon Marquis might now find congenial hosts in the new varieties.

Moreover, the work of Craigie (*1, 2*) suggested that physiologic forms might hybridize upon the barberry and thereby produce new forms. As no systematic study had been made in Canada of the physiologic forms arising from barberries, the search for physiologic forms had now to include this source also. A comparison could then be made between the physiologic

*Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa, Canada.

†The writers are indebted to Dr. E. C. Stakman and Dr. M. N. Levine for assigning numbers to the new physiologic forms and for verifying the writers' results on the infection capabilities of these forms. A recent personal communication from Dr. Levine states: "Of the eight forms that you have discovered at your laboratory only three were simultaneously discovered by us, viz. Forms 38, 52, and 50; of the remaining five, only 49 and 56 have been found by us in the United States or elsewhere, subsequent to your discovery."

forms occurring in a district one year and the forms isolated from barberry the following year. As this shrub is practically non-existent in western Canada, the number of cultures from naturally infected plants was very limited. At Winnipeg, however, barberries were artificially inoculated each year by rust collected in that vicinity. The aeciospores arising from such infections were then transferred to wheat and the physiologic forms obtained identified.

As a result of this study, a number of new forms of rust have been isolated. Below are listed the cultures of 1926 and 1927 from which the new forms were obtained, together with the date of collection and the hosts on which collected. Their distribution by provinces and their reactions on the twelve differential hosts are given in tables 2 and 4 respectively.

TABLE 1.—*Localities in which the eight new physiologic forms were collected, with date of collection and the host upon which found.*

Locality in which collected	Date of collection	Host on which collected
PHYSIOLOGIC FORM 38		
Brandon, Man.	22–7–26	Mindum
Sault Ste. Marie, Ont.	15–8–26	*Hordeum jubatum*
Kapuskasing, Ont.	25–8–26	*Hordeum jubatum*
Kapuskasing, Ont.	25–8–26	Kubanka
Kapuskasing, Ont.	25–8–26	Garnet
Kapuskasing, Ont.	25–8–26	Mindum
Winchester, Ont.	26–8–26	Barley
Mountain, Ont.	2–9–26	Barley
St. Anne de la Pocatiere, Que.	4–9–26	Kubanka
St. Anne de la Pocatiere, Que.	4–9–26	Mindum
St. Anne de la Pocatiere, Que.	4–9–26	Marquis X Kanred
Ste. Anne de Bellevue, Que.	–9–26	Manchurian Barley
Fredericton, N.B.	–9–26	Manchurian Barley
Fredericton, N.B.	–9–26	Little Club
Fredericton, N.B.	–10–26	Barletta
Fredericton, N.B.	–10–26	Durum wheat
Fredericton, N.B.	–10–26	Barley
Fredericton, N.B.	–10–26	Barley
Saskatoon, Sask.	3–7–27	Common wheat
Saskatoon, Sask.	3–7–27	Common wheat
Winnipeg, Man.	6–7–27	Winter wheat
Letellier, Man.	11–7–27	Ruby
Fort Garry, Man.	11–7–27	*Hordeum jubatum*
Roseisle, Man.	15–7–27	Marquis
Sanford, Man.	16–7–27	*Hordeum jubatum*
Indian Head, Sask.	25–7–27	Odessa
Rush Lake, Sask.	29–7–27	Common wheat
Kentville, N.S.	4–8–27	Garnet
Kentville, N.S.	13–8–27	Parker's
Kentville, N.S.	13–8–27	Manchurian Barley
Kentville, N.S.	14–8–27	Little Club
Vegreville, Alta.	15–8–27	Common Wheat
Lloydminster, Alta.	16–8–27	Marquis
Guelph, Ont.	17–8–27	Kubanka
Collingwood, Ont.	18–8–27	Barley
Ste. Anne de la Pocatiere, Que.	23–8–27	Garnet
Nappan, N.S.	26–8–27	Little Club
Nappan, N.S.	28–8–27	Garnet
Fredericton, N.B.	28–8–27	Marquis
Fredericton, N.B.	28–8–27	Garnet
Kentville, N.S.	2–9–27	Marquis
Vonda, Sask.	3–9–27	*Hordeum jubatum*
Kapuskasing, Ont.	15–9–27	Kubanka

Physiologic Form 48		
Ottawa, Ont.	31–8–26	Arnautka
Physiologic Form 49		
Arnes, Man.	1–8–26	*Hordeum jubatum*
Charlottetown, P.E.I.	11–8–26	McKenzie's
Indian Head, Sask.	10–9–26	Axminster
Winnipeg, Man.	25–6–27	Barberry
Carlyle, Sask.	16–7–27	Marquis
Brandon, Man.	20–7–27	Marquillo
Balcarres, Sask.	22–7–27	Marquis
Winnipeg, Man.	23–7–27	*Elymus canadensis*
Edmonton, Alta.	12–8–27	Fulcaster
Hayter, Alta.	18–8–27	Marquis
Ste. Anne de Bellevue, Que.	20–8–27	Barley
Odessa, Sask.	–8–27	Marquis
Winnipeg, Man.	26–10–27	Barberry
Physiologic Form 50		
Rosthern, Sask.	25–7–27	Red Fife
Woodside, Man.	27–7–27	Marquis
Collingwood, Ont.	18–8–27	Barley
Lacombe, Alta.	22–8–27	Marquis
Physiologic Form 52		
Brandon, Man.	22–7–26	Garnet
Winnipeg, Man.	21–6–27	Barberry
Winnipeg, Man.	21–6–27	Barberry
Winnipeg, Man.	23–6–27	Barberry
Winnipeg, Man.	27–6–27	Barberry
Winnipeg, Man.	27–6–27	Barberry
Winnipeg, Man.	27–6–27	Barberry
Vanscoy, Sask.	–7–27	Marquis
Winnipeg, Man.	6–8–27	Barberry
Swan River, Man.	11–8–27	Marquis
Winnipeg, Man.	18–8–27	Barberry
Winnipeg, Man.	25–8–27	Barberry
Winnipeg, Man.	25–8–27	Barberry
Saskatoon, Sask.	–8–27	Vernal X Marquis
Physiologic Form 53		
Ottawa, Ont.	18–8–27	Arnautka
Physiologic Form 56		
Winnipeg, Man.	8–9–27	Barberry
Physiologic Form 57		
Winnipeg, Man.	29–10–27	Barberry

TABLE 2.—*Distribution, by provinces, of new physiologic forms of P. graminis tritici in Canada in* 1926 *and* 1927.

Province	Physiologic forms							
	38	48	49	50	52	53	56	57
Prince Edward Island	--	--	1	--	--	--	--	--
Nova Scotia	7	--	--	--	--	--	--	--
New Brunswick	8	--	--	--	--	--	--	--
Quebec	5	--	1	--	--	--	--	--
Ontario	10	1	--	1	--	1	--	--
Manitoba	6	--	5	1	12	--	1	1
Saskatchewan	5	--	4	1	2	--	--	--
Alberta	2	--	2	1	--	--	--	--
Total number of isolations of all forms	43	1	13	4	14	1	1	1

TABLE 3.—*Relative prevalence, by provinces, of new physiologic forms of P. graminis tritici in Canada in* 1926 *and* 1927.

Province	Number of isolations of new forms	Number of isolations of all forms	Isolations of new forms in per cent of all isolations
Prince Edward Island	1	15	6.6
Nova Scotia	7	22	31.8
New Brunswick	8	38	21.0
Quebec	6	32	18.7
Ontario	13	58	22.4
Manitoba	26	363	7.2
Saskatchewan	12	284	4.2
Alberta	5	92	5.4

TABLE 4.—*Mean infection produced by eight new physiologic forms of Puccinia graminis tritici on differential varieties of Triticum spp.*

Physiologic Forms	Infection means on Lc	Ma	KRd	Ko	Arn	Mnd	SpM	Kub	Ac	Enk	Ver	Kpl
38 ----	4	2=	4—	3—	x+	x±	x+	x+	x++	4—	1=	1+
48 ----	4+	1	0;	1+	x+	x=	x±	x+	4—	4=	1=	1+
49 ----	4	4—	0	4=	1=	1—	0;	x=	3+	1—	0;	1=
50 ----	4+	2+	0;	2+	1—	0;	0;	x=	x±	0;	0;	0;
52 ----	4	4	4—	4	1=	1=	1=	3++	4	4—	4+	1—
53 ----	4	2±	0	1	4	4	4	4	4	3±	3±	1
56 ----	4	3+	4—	3+	0;	0;	0;	3+	3+	1—	1—	1
57 ----	4	4—	0	4—	1	1	1	3+	4—	3+	3+	1

EXPLANATION OF TERMS IN TABLE 4.

The following symbols, adapted from Stakman and Levine (*10*), are used in the table to indicate the types and degrees of infection on the varieties tested.

Types of Infection

O indicates that plants are immune; no uredinia are developed and hypersensitive flecks are usually not present.

O; Plants are immune, no uredinia are developed, but hypersensitive flecks occur. The rust organism has entered the host tissues but the host is so uncongenial that development soon ceases.

1 Plants are very resistant. Uredinia are very small and surrounded by sharp, hypersensitive, necrotic areas.

2 Plants are moderately resistant. The uredinia are small to medium in size; hypersensitive areas present in the form of necrotic halos, surrounding green islands in the center of which the uredinia are usually located.

3 Plants are moderately susceptible. The uredinia are of medium size, sometimes, but infrequently coalescing. Necrosis and hypersensitiveness are absent but chlorotic areas may surround the uredinia.

4 Plants are very susceptible. The uredinia are large and usually coalesce to form large irregular pustules. Hypersensitive and necrotic areas are absent but chlorotic areas may surround the pustules.

X Plants are heterogeneous in their reaction. All the above reactions may occur together on the same leaf. Certain physiologic forms react in this manner on some varieties, especially on some of the durum wheats.

Degrees of Infection

(=) Trace. Uredinia are few and small and rust development poor.
(—) Slight. Rust development slightly better than "Trace".

(±) Degree of infection moderate for its type of infection.
(+) Degree of infection considerable. Infection above the normal of its type.
(++) Degree of infection abundant. The development of rust much above the normal for its type of infection.

As examples of the above, 1= represents a higher degree of resistance than 1—; on the other hand 4++ indicates a greater susceptibility than 4+, which again indicates greater susceptibility than 4.

Discussion

From tables 1 and 2 it will be seen that eight new physiologic forms of *P. graminis tritici* Erikss. & Henn., have been isolated in Canada during the years 1926 and 1927. Four of these have been isolated from uredinial material collected in the field, two from both uredinial and aecial material, and two from aecial material only. The distribution of these eight new forms is shown in tables 1 and 2. The figures represent the total number of times each form was isolated in the different provinces.

Of those forms originating from uredinial material, form 38 is widely distributed in eastern Canada. Forty-three isolations of this form were made in Canada. Of these, thirty came from the five eastern provinces, the remaining thirteen from the prairie provinces. When one considers that the rust survey in the west was much more intensive than in the east, it becomes evident that form 38 is characteristically an eastern form. It is in fact one of the prevailing forms. Form 48 and form 53 were each collected but once, the former at Ottawa, Ont., in 1926 and the latter at Ottawa also, in 1927. Form 50 was first isolated in 1927, one culture being obtained from each of the four provinces, Ontario, Manitoba, Saskatchewan, and Alberta.

Of the two forms arising from both uredinial and aecial material, form 49 was found more frequently in the prairie provinces than in the eastern provinces, owing possibly to the more intensive survey in the former. Form 52, on the other hand, was collected only in the west. Four of the collections came from uredinial material, and ten from barberries artificially inoculated. One of these ten differed from the normal rust in the colour of its urediniospores which appear greyish-brown when viewed in mass by the naked eye. Its colour is identical with that of the greyish-brown mutant described by the writers in an earlier paper (*7*). The material for the inoculations was collected at Winnipeg. This form has never, however, been found in the uredinial stage in the vicinity of Winnipeg.

The two forms isolated from barberry alone, originated from telial material collected at Winnipeg. Form 56 resulted from artificial inoculations of barberry plants in the greenhouse. Form 57 also arose from barberry plants which were artificially inoculated in the greenhouse. The aecial material from which this form resulted was turned over by Mr. J. H. Craigie to the writers for identification.

As might be expected the new forms do not comprise a very large proportion of the total number of isolations. Owing to the preponderance

of form 38 in eastern Canada, the proportion is larger in that area than in western Canada, as is shown in table 3.

Some evidence has been found suggesting a possible relationship between the introduction of new wheat varieties into an agricultural area and the introduction there of new physiologic forms. For instance, form 38, a form to which Marquis is resistant, was discovered in 1926. At that time it was present in seventeen of the one hundred and eight isolations originating in eastern Canada, but it was found in only one of the two hundred and eighty-six from western Canada. The reason for this was not entirely clear, but it was known that while Marquis was grown almost exclusively in the west, a greater variety of wheats was grown in the east, and, as Marquis is resistant to form 38, it seemed possible that this form had been prevented from spreading westward by the scarcity of suitable host plants. In 1927, owing to the unusually late spring and the consequent fear of rust, durum wheats and varieties other than Marquis, such as Garnet and Axminster, were planted in many localities, and as greenhouse experiments had already shown that some of these were susceptible to certain forms to which Marquis was resistant (*6*), the question naturally arose, would an extensive introduction of these wheats bring about an appreciable change in the prevalence of forms found in the west? The results given in table 2 seem to indicate a slight change. It will be seen that the new form, 38, was present in the west in 1927 and appeared in thirteen of the collections made that year. Another new Marquis-resistant form, 50, also made its appearance. The latter was found on cereals, the former on cereals and grasses.

Moreover, forms to which Marquis is resistant are apparently on the increase in western Canada. Prior to 1926, a form to which Marquis was resistant was found only once in western Canada. In 1926, out of two hundred and eighty-six isolations of physiologic forms made in the prairie provinces, Marquis was resistant to only three. In the following year, 1927, out of four hundred and fifty-four isolations from the prairie provinces, Marquis was resistant to thirty-two. That is, the proportion of Marquis-resistant forms had increased from one per cent in 1926 to seven per cent in 1927.

To draw any final conclusions as to how these new forms of rust originated would be unwarranted. It is not known whether they always have been present and merely escaped detection in previous years, or whether they have arisen through hybridization or mutation. To establish either of the latter possibilities it would be necessary to know the original form or forms which produced the infections on the barberry. This information is not available but the results are at least suggestive. Forms 56 and 57 have been found only in collections from barberries which were infected with telial material gathered at the Agricultural College, Winnipeg. A number of the commonly occurring forms were found also in this material. The occurrence of form 52 ten times in rust collections from barberry infected with rust collected at Winnipeg would indicate that this form was prevalent in that vicinity, but up to the present it has never been obtained from uredinial material collected around Winnipeg. It has, however, been found in that stage farther west. It might be pointed out also that forms 48 and

53, each of which has been collected but once, were found at Ottawa in the rust nursery rows which were planted in close proximity to a barberry hedge. Notwithstanding these results the ability of rust strains to hybridize on the barberry can only be demonstrated when, under rigidly controlled conditions, two forms of rust give rise to another form which is distinct from them.

Summary

1. Eight physiologic forms of *Puccinia graminis tritici*, different from any previously described, have been identified in Canada during the years of 1926 and 1927.
2. Four of these forms, 38, 48, 50, 53, were collected only on cereals and grasses. Two forms, 49 and 52, were collected on cereals and grasses and on barberry. The remaining forms, 56 and 57, occurred only in rust collections obtained from barberry.
3. There seems to be some correlation between the introduction of new wheat varieties into a district and the occurrence there of new physiologic forms.

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OBSERVATIONS ON CUTTINGS OF A VARIETY LILAC

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Introduction

This study of propagation by cuttings was prompted by the fact that, although increasing numbers of plants are being propagated by this means, there are still many valuable fruit trees, ornamental shrubs and flowering plants which fail to give any measure of success when this method is employed. It would seem from recent research that it may be true, as Bayley Balfour (*3*) contended, that it is possible to reproduce any plant by stem cuttings, if the material is employed while in a suitable physiological state and if it is given a suitable environment. To do this would entail a knowledge of the constitution of the plant both anatomically and physiologically in order that appropriate material and conditions might be employed.

Examination of the literature reveals plainly that the intensive investigation of this field is only just begun. The number of communications on the subject is very large, but in few instances have the authors attempted to analyse the complex of factors surrounding the problem or to develop working hypotheses. Commenting on this Zimmerman (*21*) says, "In spite of the great importance of propagation by means of cuttings, no adequate investigations have as yet been reported concerning the underlying principles and factors involved. The mere fact that we have no such explanations is an indication that the problem is difficult".

There are certain well-defined reasons for desiring to propagate plants on their own roots. In the first place, the employment of seedling stocks or stocks of other plants for budding or grafting, in addition to being a costly method of propagation, introduces a factor of variability. Statistical studies such as those by Batchelor and Reed (*2*), Hedrick and Anthony (*9*), Anthony and Waring (*1*), Sax and Gowen (*16*) have clearly shown the range of variability in production and growth of grafted orchard trees even under the uniform conditions of plot experimentation. Maney (*14*) has recently pointed out that the most carefully planned fertilizer test with orchard trees in America, namely the New York Experimental Station project, has a coefficient of variability of 23 per cent. At the Pennsylvania Station the coefficient runs up to 35 per cent. With the object of investigating the causes of this variability the Massachusetts Agricultural Experiment Station started a project in 1912 which will have a twenty-year duration. In the light of present knowledge it seems that of the various factors which may influence individual behaviour and so contribute to variability, such as soil type, mechanical injury, insect and disease infestation, cultural methods and variable seedling root stock, the most important is the last-named. The work of Webber (*19*), Bregger (*4*), and Hatton (*8*) indicates to how remarkable an extent the stock may influence the scion in a fruit tree graft. It is clear, therefore, that in order to smooth out individual differences in the growth and productivity of grafted fruit trees

it will be necessary to secure trees worked on really uniform stocks that are themselves vegetatively propagated. This is an exceedingly difficult object to attain, and constitutes one of the most serious objections to this method of propagation.

Another objection which may be urged is the lack of hardiness of trees grafted on seedling roots as compared with own-rooted trees. As long ago as 1873 Budd (*5*) at Iowa State College found that own-rooted apple trees, secured by deep planting of long-scion seedling root-stock whip grafts, were hardier as well as less variable than those on seedling roots. In a series of experiments carried out to test the relative hardiness of apple roots Potter (*15*) found that scion roots from varieties considered to be hardy were on the average much hardier than seedling roots. Yerkes (*20*) comes to similar conclusions. Gersdorff (*7*), working with climbing roses and certain varieties of hybrid tea and hybrid perpetual roses finds that these plants do better on their own roots.

The evidence from the standpoint of practice clearly shows the inadvisability of using seedling stocks with horticultural plants wherever any alternative is possible and we may agree, therefore, with Vierheller (*18*) when he draws attention to "the fact that hardiness, disease resistance, yield, growth habit, vigor and perhaps quality of the fruit may be affected by the root"—and that "the great variability of seedling roots is a matter of common knowledge". We may follow him in his conclusion also, that: "It would be of immense value if this variability could be eliminated by producing trees on their own roots, without the expense of root grafting".

From the standpoint of economy it must be recognized that budding and grafting have the further disadvantages of greater costliness and hazard as compared with propagation by cuttings. In this connection Zimmerman (*22*) says: "Rooting cuttings is much less expensive and in some cases less hazardous than grafting or budding and needs a thorough study to see to what degree it may be used to displace these more expensive and more hazardous methods of propagation".

The lilac was chosen as experimental material for this investigation because propagation by budding and grafting of the finer varieties is attended by all the disadvantages enumerated above, and in addition by certain special disadvantages. The chief of these is that the two plants most commonly employed as root stock are both, for different reasons, objectionable.

European nurserymen commonly propagate the better lilac varieties by budding or grafting them on seedling stocks of *Syringa vulgaris*. This type of stock possesses a conspicuous fault. John C. Wister, a recognized authority on lilacs, draws attention to this fault when he states: "This practice produces good plants but they are open to the very serious objection that any sucker which may come from the seedling stock cannot be distinguished from the shoots of the named variety. Whatever theoretical points may be in its favor the practical results are that after a few years in most gardens the named variety disappears and nothing but the seedling stock remains."

Another method which has frequently been employed in the commercial propagation of lilac varieties has consisted of budding or grafting them on privet (*Ligustrum ovalifolium*) stock. This is still the chief method em-

ployed by American nurserymen. In spite of its wide use, however, it is not without a number of serious faults. Hottes (*11*) discussing the relationship between the scion and the stock states: "It is a well-acknowledged fact that grafting a weak-growing scion on a strong-growing stock shortens the life of the tree or shrub". This explains why lilac-variety scions grafted on privet stock produce short-lived plants. Another serious objection which nurserymen raise to the use of privet as a stock for lilac varieties is its tendency to produce dwarfed plants. Lilac plants propagated in this manner and growing on the grounds of the Ontario Agricultural College reveal this fault to a marked degree. A further objection to use of privet as a stock consists in the fact that it produces "suckers" which must constantly be pruned back.

Thus, it is plainly seen that methods employed in propagating our choice lilac varieties, namely by budding and grafting them on seedling stocks of *Syringa vulgaris* or *Ligustrum ovalifolium,* are far from satisfactory. There seems every reason for believing that propagation by means of cuttings would largely remove the objectionable features of the methods now employed. Attempts in the past to propagate variety lilacs by means of cuttings have not been attended with any degree of commercial success. This appears to be due in no small measure to the fact that purely empirical or "rule of thumb" methods have been employed, a fact which indicates that we are not yet in a position even to state the problem in terms of the physiological and anatomical properties of the material. Opportunities for investigation therefore abound.

Methods

The choice varieties of *Syringa vulgaris,* commonly catalogued as French lilacs and of which several plants of the better varieties were growing under similar environmental conditions on the O.A.C. grounds, seemed most nearly to fit the requirements of availability and uniformity. These were, therefore, selected as the most suitable material for these experiments. A few months' experience indicated the advisability of restricting the work to a single variety, and since it offered the greatest quantity of available experimental material, the variety Ludwig Spaeth was chosen. The results given in this paper were obtained by the use of cuttings from this variety alone.

The cuttings used in all experiments, except where otherwise designated, were secured by cutting the terminal shoots of the current year's growth into six inch lengths. Shoots of approximately the same diameter and with an equal number of nodes were as far as possible selected. In this way it was hoped to secure a fairly large amount of consistent material. Preliminary experiments had shown that, under proper environmental conditions, callusing which is generally conceded to be indicative of suitable conditions for root formation, proceeded rapidly on cuttings of this length.

The cuttings in all experiments were planted in flats 12 inches wide, 12 inches deep and 36 inches long. These dimensions would allow both deep and shallow planting. They would also give sufficient room for 200 cuttings in each flat, thus providing a greater likelihood of a consistent environment than a larger number of smaller flats would have done.

During the course of these experiments two greenhouses in the range at the Horticultural Department of the Ontario Agricultural College were employed. One of these was kept at a low constant temperature in the neighbourhood of 50°F and the other at a warmer temperature around 77°F. A fairly high soil temperature ranging from 60° to 70°F. was secured in both houses by means of steam pipes placed beneath the compartments in which the flats were contained. These compartments closely resembled propagating boxes in their construction. They were of sufficient size to hold six flats and instruments. The tops were generally left open but were provided with duck sun-screens which could be drawn on very bright days when otherwise the temperature in the compartments would rise too high. The temperature in both houses was raised by opening the valves on the steam pipes and lowered by closing these and opening the ventilators at the top of the houses. Air temperature was measured at first by a self recording thermometer placed in each greenhouse and later by periodic readings made throughout the day. Air temperature of cuttings kept in cold frames under low temperatures was secured by maximum and minimum thermometers. Soil temperature in all cases was determined by means of a soil thermometer, graduated in degrees Fahrenheit, placed in each flat. The humidity of the houses was measured by means of Tycos hygrometers. Readings were made each day in the morning, at noon and again in the evening. Such records kept a check on the constancy of external conditions, which, because they have such important effects upon growth, must first be ruled out before difficulties inherent in the material itself can be approached.

The media selected for use in the first part of these investigations were American peat, silver sand and a mixture of the two in equal parts by volume. The first of these was secured from Pefferlaw, Ontario, and the second was a Georgia sea sand neutralized with acid and washed in distilled water. An analysis of the peat ash showed it to consist of:

silica	18.17%
alumina	9.6 %
ferric oxide	7.6 %
lime	31.6 %
magnesia	14.6 %
potash	.8 %
soda	4.7 %
sulphuric acid	3.9 %
phosphoric acid	1.3 %

An analysis of the silver sand showed it to be practically 100% silica. The moisture holding capacity of the three media under the conditions provided was roughly as follows:

silver sand	6 to 10%
peat sand	20 to 30%
peat	65 to 75%

The relative acidity as determined by average sample was:

peat pH	5.32%
peat sand pH	6.23%
silver sand pH	6.92%

Results of early experiments showed that peat was very adverse in its effect upon *Syringa vulgaris* cuttings, while the best growth resulted in silver sand. The latter was, therefore, chosen as the medium for all subsequent experiments.

EXPERIMENTAL RESULTS

The experiments here reported fall naturally into two groups: cuttings which were secured from resting wood of the previous season's growth and cuttings which were made from actively growing wood of the current season. The observations will be dealt with in this order.

Experiments with Dormant Cuttings

The nature of the rest period. The phenomenon of rest is a matter of perennial interest to students of plants and since it has been shown by Howard (*12*) and others that different species differ in respect of the properties of the rest period, I have endeavoured to make observations which would yield information concerning the nature of the rest period in this variety of lilac. The most enlightening of these consisted in a simple series of experiments in which cuttings were taken at intervals from early September until the early part of the following July. These cuttings were set out in the greenhouse in silver sand at a temperature range of 70°-80°F. and maintained under conditions favourable for growth until they were dead or were retrogressing rapidly. They were examined for bottom growth at the end of about eight weeks in each case. At this time the majority usually being dead or dying, they were removed from the flats, dried and put away dry for future examination into the state of their food reserves. Table 1 summarizes the observations.

Table 1.

Lot. No.	No. of cuttings	Date set out	Date removed	Result
1	80	Sept. 10, 1926	Nov. 12, 1926	Buds just started
2	80	Sept. 22, 1926	Nov. 25, 1926	No activity.
3	80	Nov. 15, 1926	Jan. 10, 1927	No activity.
4	80	Dec. 14, 1926	Feb. 15, 1927	No activity.
5	80	Dec. 30, 1926	Feb. 27, 1927	Top growth only.
6	80	Jan. 10, 1927	Mar. 12, 1927	Active top growth only.
7	80	Mar. 24, 1927	May 25, 1927	Active top growth and callus.
8	80	Apr. 21, 1927	May 15, 1927	Lost by Botrytis infection.
9	80	June 16, 1927	Nov. 20, 1927	Callus and roots.
10	80	July 9, 1927	Nov. 20, 1927	Callus and roots.

The table shows plainly that from mid-September to mid-December adjustment of the ordinary external environmental factors to a range appropriate for growth is insufficient to start activity in these cuttings. After this period such an adjustment is sufficient to bring the rest period to an end. This enables us to draw an hypothetical picture of the nature of the rest period in these cuttings which may help us to further advances in this problem. It seems clear that the period from mid-September to mid-December is different in its properties from the period which succeeds it. From mid-December on the buds at least appear to be ready to resume activity provided only that environmental conditions are such as to permit

growth. Their state of quiescence during this period is therefore directly imposed upon them by conditioning external factors. This is not true of the September-December period, during which time the state of rest must be determined by factors internal to the cuttings. The evidence suggests, therefore, that the winter rest-period in lilac stems is a physiological complex consisting of a period of true dormancy (September to December) followed by what we may call a period of "externally-conditioned quiescence". It is hardly likely that the material would pass suddenly from the state of true dormancy to a state in which the resting condition is entirely imposed from without. From theoretical considerations it is more to be expected that the transition would be gradual and that the determination of rest by internal factors slowly passes over into a condition in which rest is determined more and more, and finally completely, by external factors. This expectation would seem to imply a gradually increasing capacity for growth on the part of cuttings taken at intervals from December to spring and set out under conditions suitable for growth. Table 1 shows us that this implication is realized. At first the only growth is that of the buds, which develop for some time and then die without any appearance of activity at the lower extremity of the cutting. By March, bud growth is succeeded by the development of callus, which is an indication that cambial activity has begun and has extended to the bottom of the cutting. At no time, however, did cuttings taken during any portion of the period of rest produce roots. This result only follows in cuttings taken after the rest period is past and its significance will, therefore, be discussed in a later part of this paper.

The relation between top growth and bottom growth. There exists a diversity of opinion on the important question as to whether the development of buds and the formation of callus in a cutting taken during the rest period are correlated. Certain observations were made which bear on this question and these are dealt with under the four heads which follow:

(a) *Apparent existence of a correlation.* Callus formation on cuttings taken during the rest period was found to occur only where bud activity had previously manifested itself. This is illustrated in Table 1 which, however, does not by any means record all the observations upon which this statement is based. On the other hand, bud development is not necessarily followed by callus formation, as we see in the December and January cuttings of Table 1. Therefore it would appear that if some phenomenon connected with the growth of buds should be a necessary preliminary to callus formation, the relation must be complex.

(b) *Effect of bud removal.* The removal of all buds from lilac cuttings taken at any point in the rest period had so unfavourable an effect that such cuttings invariably died in two or three weeks time. In no instance was there any evidence of callus formation in such cuttings, though from March onward, the controls did form callus. When the two terminal buds alone were removed from cuttings taken in March, this resulted in the growth of lower buds, but the growth was delayed three weeks as compared with the growth of the terminal buds left on the controls. No callus formation took place on the disbudded cuttings, though the controls were active in this respect.

Fig. 1.

Fig. 2.

Figure 1.—Localized callus formation on the same side as the strongly sprouting bud.

Figure 2.—Localized callus formation on the same side as the more strongly growing shoot.

(c) *Callus localization.* One of the two terminal buds of a lilac cutting commonly grows out into a shoot more rapidly than the other. Where this discrepancy was pronounced, callus development began on that part of the cut surface immediately below the more actively growing bud, and from that point spread over the whole cut surface. Where forked cutting were employed in addition to simple cuttings,the initial formation of callus had the same relation to the dominant shoot. This is illustrated in text figures 1 and 2. It is interesting that in attempts to compare long and short cuttings, initial localization of callus was observed to be more pronounced in short cuttings of two or three internodes than in longer cuttings of five or six internodes. The removal of the less active bud was carried out in one lot of cuttings as soon as it could be distinguished with certainty, and in these the localization of the callus was considerably more pronounced than in the controls.

(d) *Heat stimulation.* A variety of experiments was performed with a view to breaking the dormancy of cuttings taken during the September-December period. One of these experiments was carried out in the hope that callus formation might be induced in the absence of bud activity. The result is shown in Table 2. The cuttings, taken early in the dormant period, were stood with the cut ends immersed in water maintained at the temperatures shown in the table. What followed when the cuttings were set out immediately after treatment, showed that though dormancy had been broken, the buds alone had become active. Curtis found a similar response in dormant *Ligustrum* cuttings when treated in this manner.

TABLE 2.—*Effect of preliminary treatment with warm water upon cuttings set out in silver sand.*

Time	Treatment	Bud growth	Callus formation
Sept. 22, 1927	40°C for 2 hours	active	none
Nov. 14, 1927	20°C for 2 hours	slight	none
	No immersion in water	none	none

That there is some sort of correlation between bud growth and callus formation in lilac seems indicated, therefore, by the observations:

1. That callus was only observed to form where buds are active.
2. That the removal of buds from cuttings which would otherwise develop a callus, prevents that development completely.
3. That the point at which callus formation begins is correlated with the position of the more active bud or shoot.

It is clear that the relationship may be complex or indirect from the facts:

1. That bud growth does not necessarily mean callus formation even in normal cuttings.
2. That in cuttings from which the terminal buds have been removed no callus is formed, (though the lower buds ultimately grow actively) whereas callus is formed in the controls.

These limited observations obviously do not by themselves enable us to picture the mechanism underlying the correlation. Of the various hypotheses suggested by other workers, the one which they seem most nearly to support is that of Professor J. H. Priestley of Leeds, which he very kindly communicated verbally. Priestley's conception appears to be that in a dormant cutting growth activity commences first in the bud and then spreads from this point downward in the cambium until the lower extremities are ultimately involved. Then and not before, will callus formation commence. The observations on lilac which most directly support this view are:

(1) That no callus was ever observed to form where buds are inactive or removed.
(2) That the growing-points of buds are much more easily activated than the other meristems of resting material.
(3) That the position of the first-formed callus-mass is determined by the position of the more active terminal bud or shoot.
(4) That this initial localization of callus is more pronounced in short than in long cuttings and where the less active bud is removed than where it is left attached.

In the light of this hypothesis it is hard to understand why callus-formation does not invariably follow the growth of buds, and the fact that it does not seems to postulate some sort of interfering mechanism. Feeling that this might possibly be the exhaustion of food reserves, the state of the reserves (starch in particular) in cuttings which had died was submitted to examination. The interesting fact came to light that even in the cuttings of September to December which do not become visibly active at all, but die before the buds burst, the food reserves are all but completely exhausted in parenchyma which at the beginning was loaded with starch. Evidently

the metabolism of dormancy at the beginning of the rest period makes away with astonishing quantities of carbohydrate at the high temperature of the greenhouse. Cuttings in which the buds had unfolded but in which callus had not formed, as well as those in which callus had formed, were, when dead, found to be depleted of food reserves. The hypothesis might be advanced that cuttings taken from the bush periodically through the rest period are able to devote a gradually increasing proportion of their reserves to the purposes of growth and a decreasing proportion to the metabolism of dormancy. But at no time under the conditions of these experiments was the available proportion of the reserves sufficient to carry growth as far as rooting or, perhaps, to bring leaves to physiological maturity and thus make the cutting independent of its reserves. This interesting point needs further investigation.

Breaking dormancy. Attempts were made by various means to break the dormancy of the cuttings during the early part of the rest period and thus to increase the proportion of reserves available for growth. None of these experiments yielded results of sufficient promise to warrant their introduction here. Until such methods are successful and until we understand the nature of the rest-period it would appear that the only hope of obtaining rooted cuttings from this variety of lilac lies in taking the cuttings at a point of time subsequent to the rest period, that is, in employing early, soft-wood cuttings.

Experiments with non-dormant cuttings

Physiological considerations. It has already been observed that the only cuttings to strike root were those taken from the shrubs in June and July, as indicated in Table 1. The cuttings were of several kinds:

1. Simple cuttings, three internodes in length, of the current season's growth only, taken by cutting diagonally between the two opposite buds of a node.
2. Simple cuttings of the current season's growth, taken by cutting at the centre of the fourth internode from the terminal buds.
3. Heel cuttings, in which a "heel" of the previous season's wood was left attached to the basal extremity of the cutting.

These cuttings were set out in two media: silver sand and peat sand. Terminal leaves were left attached, but were trimmed to about one-half their area, to avoid excessive rates of transpiration.

The simple cuttings (Pl. I Figs. 1-4) rooted more freely than the heel cuttings (Pl. II Fig. 4) in both media. This difference was most marked in peat sand in which the heel cuttings completely failed to root while the simple cuttings though rooting by no means so freely as in silver sand, nevertheless did succeed in forming roots. In the more favourable medium (silver sand) internode cuttings appeared to root better than node cuttings, but in the less favourable medium this situation was reversed. (Compare Pl. I Figs. 1-2 and Pl. I Figs. 3-4).

These cuttings were allowed to grow from June and July until November, when they were taken up for examination. The foliage persisted well during this time and probably functioned effectively in assimilation. Buds

did not grow. This fact is almost certainly correlated with the persistence of the leaves. It has already been suggested as an hypothesis that root-formation did not take place in cuttings of resting material because the reserves were insufficient to provide for the metabolism of dormancy of bud-growth and callusing as well as for rooting, processes which, taking place in this order, are brought to an end by insufficient food before the last one is complete. If we may look at the behaviour of these non-dormant cuttings in the light of this hypothesis, successful rooting would seem to be correlated in the first place with their power of continuous assimilation and in the second place with the fact that food materials were not drawn upon by developing buds. In such an event available food materials could be utilized for callus and root production alone.

Anatomical considerations. The roots invariably arose entirely from within the callus, so that some idea of the structure of this body and its mode of origin is essential to a comprehension of the origin of the roots. Specimens were therefore fixed, embedded in celloidin, sectioned and stained in order to observe the structure and origin of callus and roots.

Cambial activity within the stem of the cutting gives rise to secondary tissues in the usual manner. Near the cut surface at the lower extremity, perhaps because the bark at this point does not confine the tissues beneath it as strongly or uniformly as where it is intact, the wood so formed is larger in volume than it is further up the stem, and somewhat disorganized as wound tissue is apt to be. Figure 1, Plate II, is a photomicrograph of a transverse section taken in this region of the stem. The position occupied by the cambium at the time when the cutting was taken is shown at (C) and its new position at (C'). Between (C) and (C') lies the newly-formed secondary wood (W'), obviously different in appearance from the wood formed immediately before it (W). Vessels are absent and the direction of the radial rows has been altered, possibly by the pressure of the callus-tissues to the right. The wood of the callus (W") is obviously the product of a tangential extension of the stem cambium beyond the bounds of the stem (C") and it is therefore continuous with the new wood of the stem. These extensions of the cambium are very irregular and give rise to irregular masses of wood, as will be seen in the transverse section shown in Fig. 2, Plate II. Without the callus-cambium lies the bast (B) beyond which again is an extensive parenchyma (P) (probably largely phelloderm) bounded by a cork cambium (CC) and cork (ck). The morphology of the callus is an interesting subject in itself which will not be dealt with in further detail in this paper except to note the mode of origin of the roots. These arise from the cambium as active buds of meristematic tissue and in their early stages are very like the root primordia found in such stems as those of *Salix, Populus* and *Ribes* (Fig. 3 Pl. II (r)). The root buds grow out through the parenchyma and cork layers to the exterior. What determines the origin of roots at some points and not others is quite obscure. They appear to have no regular relation to other structures of the callus such as Van der Lek (*17*) finds existing between root primordia and primary medullary rays or leaf traces in the stems of *Salix, Populus* and other forms.

It would appear that roots develop with greater facility in the wound-tissues of the callus than elsewhere in cuttings of this plant. Much discussion

has revolved around the question of the relation of callusing to rooting. The classical view is that callus is "materia ad radices promovendas", in the words of Agricola. Recently, however, this has been questioned. Knight (*13*) found that with plum cuttings extensive callusing retarded rather than aided rooting. Hitchcock and Zimmerman (*10*) state that there is no direct relation between callus and root formation in cuttings of *Ligustrum ovalifolium* and *Azalea amoena*. In both forms good rooting took place in the absence of callus and good callus was formed without subsequent rooting.

Van der Lek (*17*) makes the situation clearer by pointing out that roots developing on cuttings are either "morphological roots" or "wound roots". Those of the former category are strictly determined as to their point of origin by certain structures of the stem to which they bear a definite relation, and they arise either from pre-formed root primordia, as in *Salix* and *Populus*, or from "groups of cells or series of cells which have a certain predisposition" for root formation but are not distinguishable to the eye as root primordia, as in *Vitis*. The wound roots, on the other hand, all spring from the vicinity of the basal wound surface, it is true, but apart from this their points of origin are apparently fortuitous. Wound roots may spring from the stem itself, a condition which Van der Lek finds very common, or more rarely, they spring entirely from the callus, as in *Thuyopsis dolabrata, Acanthopanax spinosa* and others.

Certain observers, such as Bayley Balfour (*3*) report that wounding the callus brings about early root production in cuttings of plants which tend to an excessive preliminary callus-formation. Attempts to hasten root production in *Syringa vulgaris* by this means were unsuccessful. Vierheller (*18*) was similarly unsuccessful with cuttings of apple.

Acknowledgement

This investigation was carried out under the joint supervision of Professors of the Department of Botany in the University of Toronto and the Department of Horticulture in the Ontario Agricultural College. I am partucularly indebted to Professors MacLennan, Tomlinson and Stone for the provision of facilities at the College as well as for helpful suggestions and to Professor G. H. Duff, of the University, for assistance with the literature and revision of the manuscript.

Summary

This investigation indicates that the variety-lilac employed has a period of true dormancy extending roughly from mid-September to mid-December followed by a period of "externally-conditioned quiescence" which in the case of material growing out of doors, lasts until external factors become suitable for growth in the early spring.

Cuttings taken during the period of true dormancy and set out under optimum conditions made no growth response.

Cuttings taken during the period of externally-conditioned quiescence underwent active development of buds alone during the earlier part while buds and callus developed during the latter part of the period.

Buds, callus, and roots developed only on cuttings taken during June and July when the shrubs were actively growing.

The roots arise from the cambium within the callus and not from within the stem itself.

Silver sand (pH 6.9) proved to be the most nearly ideal medium employed. Peat sand (pH 6.2) is less favourable whereas American peat (pH 5.3) had a decidedly toxic effect upon cuttings planted in it.

An hypothesis based on considerations of nutrition has been developed as a starting-point for further investigations on the behaviour of cuttings of *Syringa vulgaris*.

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EXPLANATION OF PLATES

PLATE I.

FIGURE 1. Cuttings taken at the node on June 16, 1927, and set out in silver sand. Photographed Nov. 20, 1927.

FIGURE 2. Cuttings taken at the centre of the internode on June 16, 1927, and set out in silver sand. Photographed Nov. 20, 1927.

FIGURE 3. Cuttings taken at the node on June 16, 1927, and set out in peat sand. Photographed Nov. 20, 1927.

FIGURE 4. Cuttings taken at the centre of the internode on June 16, 1927, and set out in peat sand. Photographed Nov. 20, 1927.

PLATE II.

FIGURE 1. Transverse section through basal extremity of stem showing relation of stem tissues to callus. Tissues x62.

FIGURE 2. Section through callus showing its structure. x12.

FIGURE 3. Section through callus showing the formation of a root. x26.

FIGURE 4. Heel cuttings taken June 16, 1927, and set out in silver sand. Photographed Nov. 20, 1927.

c—Position of stem cambium at time of setting out.
c'—Position of stem cambium after 5 months.
c"—Callus-cambium.
cc—Cork cambium of callus.
w—Stem-wood formed before setting-out.
w'—Stem-wood formed during growth of cutting.
w"—Callus-wood.
b—Bast of callus.
p—Parenchyma (phelloderm) of callus.
ck—Cork.
r—Root primordium.

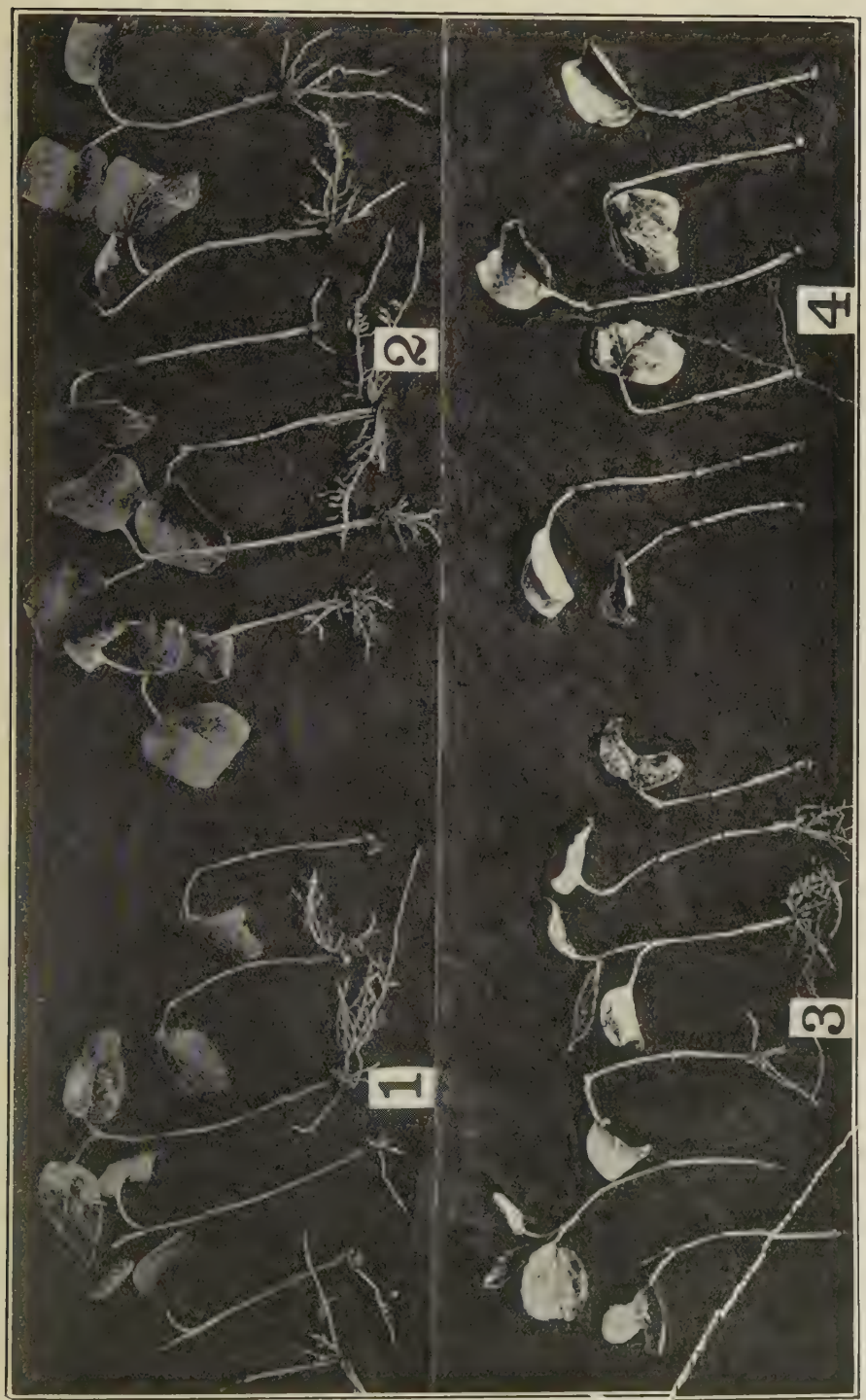

PLATE I.

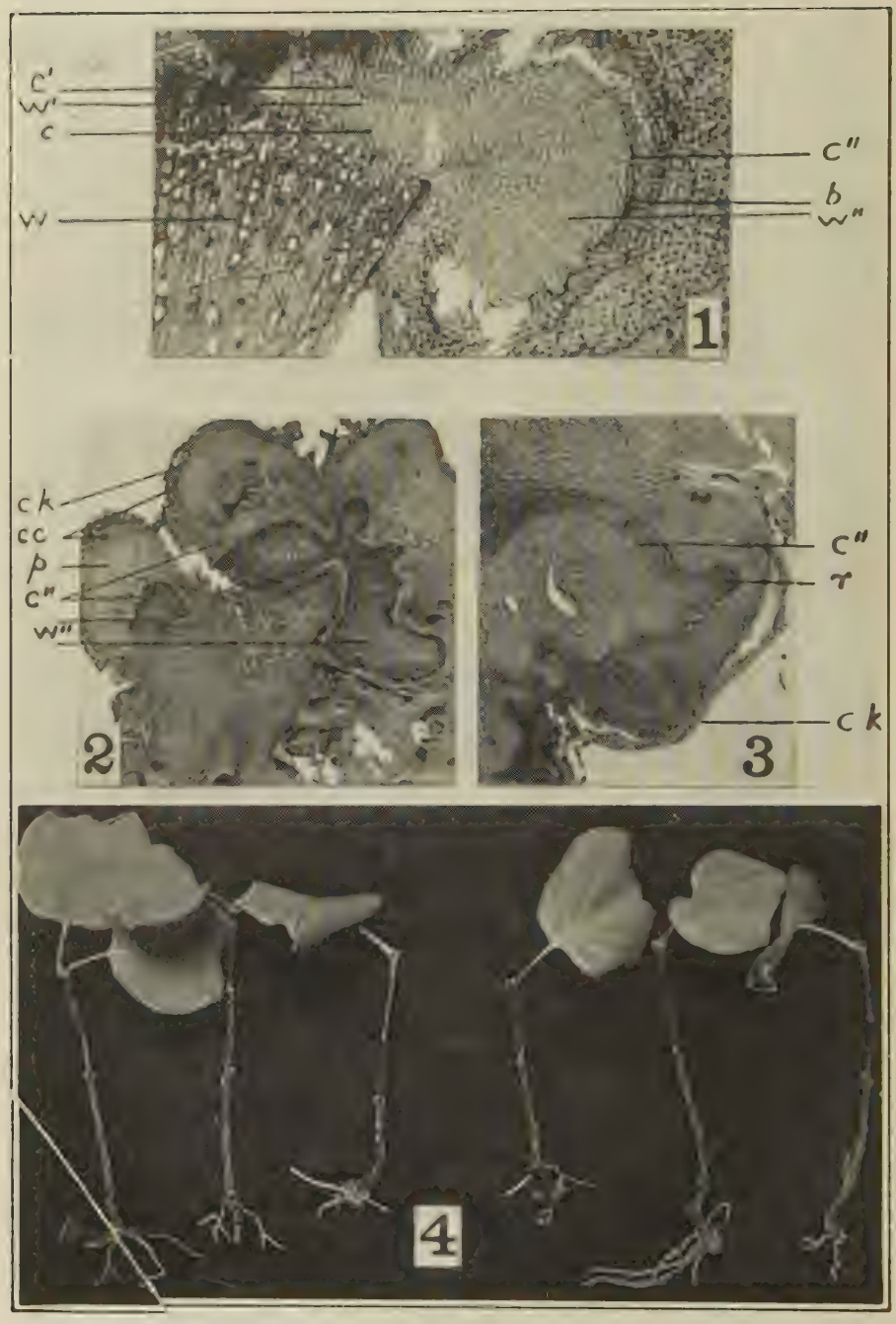

PLATE II.

A CONTRIBUTION TO OUR KNOWLEDGE OF

THE NITROGEN CONTENT OF RED RIVER VALLEY SOILS

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Introduction

The soils of the Red River Valley, which occupy some three and one half million acres in Southern Manitoba (*5*) have enjoyed the reputation of having an exceptionally high nitrogen content. This reputation arose in the early days of settlement from the reports of land surveyors, botanists and geologists, etc., in which were described the dark colour and depth of the soils, and also the remarkably vigorous vegetation which was observed. The few analyses of the nitrogen content which were made later, strengthened this reputation, and the question has arisen whether the nitrogen content of the Red River Valley soils has not been over-estimated.

The report by Dr. G. M. Dawson (*3*) contains the following reference to these soils: "Of the alluvial prairie of the Red River much has been said already and the uniform fertility of this soil cannot be exaggerated. The surface for a depth of two to four feet is a dark mould composed of the same material as the sub-soil but mingled with much organic matter..... The fertility of the ground may be considered as practically inexhaustible".

In 1882, J. Macoun (*7*) in writing of the grassy prairies of the Red River Valley stated that the soil of this lower plain is "dark coloured alluvium of great depth, and of almost inexhaustible fertility".

The first figures relative to the nitrogen content of these soils were published in 1885 when Lawes and Gilbert (*6*) reported the analyses of samples of soil from three locations in the Red River Valley, which created a reputation for these soils and aroused considerable interest in the development of the virgin prairies of Western Canada. Their analyses are given in Table 1.

Table 1.—*Nitrogen content of Red River Valley soils in per cent of dry soil. Reported by Lawes and Gilbert.*

Sample from	Depths in Inches			
	0–12	13–24	25–36	37–48
Selkirk	.618	.264	.076	.042
Winnipeg	.428	327	.158	.107
Niverville	.261	'69	.069	.038

In commenting on these samples (which were recognized as being of an exceptionally high nitrogen content) Lawes and Gilbert stated that they observed undecomposed organic material in the soil samples. This they apparently considered to be extraneous material. They stated that "the amount of carbon found and its proportion to nitrogen in some of the subsoils is, however, so high that it is obvious the samples were not quite free from particles of undecomposed vegetable residue, although all that was possible was picked out before the samples were submitted to analysis".

In 1910 Alway and Vail (*1*) made a study of the soils at the Indian Head Experiment Station some 250 miles west of the Red River Valley.

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They drew attention to the hummocky condition of the virgin prairie at Indian Head and to the higher accumulation of nitrogen, carbon and humus found under the rifts between the hummocks, when compared with the soil found under the summit of the hummocks. These authors suggest that the soil samples from the Red River Valley reported by Lawes and Gilbert were probably obtained from below the rifts in hummocky prairie similar to the condition found by Alway at Indian Head.

Field investigations to verify this suggestion appear to have been neglected, although subsequent analyses of soils from this area have been reported.

Shutt (*8*) in 1910 reported laboratory studies on three samples of soil from the Red River Valley, without comment on the depth from which the samples were obtained. The figures as reported are given in Table 2.

TABLE 2.—*Percentage of nitrogen on a water free basis in Red River Valley soils, Reported by Shutt.*

Sample from	Per cent of Nitrogen
Morris (virgin soil)	1.005
Portage la Prairie (virgin soil)	.651
Portage la Prairie (cropped 25 years)	.506

Other references giving figures of nitrogen content of Red River Valley soils are citations of the above, and it is evident that the information to date on these soils has been very inadequate. The only other data, relative to this subject, available to the authors, are some unpublished analyses compiled by C. B. Clevenger (*2*) who collected a number of samples of soil from the Municipality of Morris in connection with the Agricultural Survey of Manitoba in 1921.

These samples collected and analyzed by Clevenger were composite samples of at least five borings taken at three arbitrary depths, namely: 0 to 7 inches; 7 to 20 inches, and 20 to 40 inches. Eighteen sets of samples were thus obtained. The records of this work by Clevenger are submitted in Table 3*.

TABLE 3.—*Per cent of nitrogen in soils of the Morris Municipality (by C. B. Clevenger).*

Lab. No.	Notation	0 to 7 in.	7 to 20 in.	20 to 40 in.
No. 15	Clay	.447	.300	.142
No. 16	"	.308	.220	.111
No. 92†	"	.480	.187	not reported
No. 94	"	.466	.213	" "
No. 133	"	.423	.213	" "
No. 135	"	.410	.254	" "
No. 139	"	.437	.136	" "
No. 140	"	.391	.176	" "
No. 148	"	.372	.197	" "
No. 149	"	278	.184	" "
No. 150	"	.318	.154	" "
No. 151	"	.436	.198	" "
No. 155	"	.533	.201	" "
No. 152	"	.362	.127	" "
No. 153	"	.403	.148	" "
No. 154	"	.409	.181	" "
No. 134	"	.478	.126	" "
No. 138	Silty clay loam	.356	.265	" "

† Virgin soil

*Subsequent field examinations by the authors, of the soils recorded in Table 3, showed that these soils contained the characteristic dark tongued intrusions described in this article.

Characteristics of Red River Valley Soils

No work relative to the nitrogen content has been done on the soils of the Red River Valley in Manitoba other than that quoted above, until 1927, when the authors of this paper made a traverse from the Red River to the western limit of the fine textured plain, commonly known as the Red River Valley. In this traverse it was observed that though different soils were found, due to variations in position, plant cover and parent material, yet, with the exception of the wet meadows, all the soils have two characteristics in common. First, it was observed that these soils have remarkable tongued intrusions of dark surface material which penetrate into the lower soil horizons; second, these tongued intrusions are confined to the heavy textured soils.

The observation of the dark tongued intrusions at once suggested wide variations in the nitrogen content of the different vertical sections, as suspected by Alway and Vail (*1*), and an attempt therefore was made to obtain information relative to the nitrogen content in tongued and not tongued portions of these soil profiles.

(a) *Soil Series.*

Four major soil series which showed the dark tongued intrusions were found in the area traversed. These have been called tentatively: 1, Red River; 2, Fort Garry; 3, St. Norbert and 4, Sperling. In view of the fact that the problem of the variable nitrogen content is linked with the characteristics of these soils, the following descriptions are submitted:

The Red River is the typical well drained upland soil profile of the area, developed under tall grass prairie vegetation on the lacustrine clay of Lake Agassiz. The surface of the virgin prairie is only slightly hummocky.

The Fort Garry at present is a transition meadow-prairie soil found in the lower portion of the plain adjacent to the Red River. The parent material of this series is alluvium and shallow lake deposit laid over the deep laminated lacustrine clays of Lake Agassiz. The surface of the virgin prairie is particularly hummocky. The hummocks are irregular in outline and three to five or more feet in diameter and raised to from four to six inches high.

The St. Norbert is a degraded soil developed under the woodland invasion of the prairie where the grass has given place to poplar and oak.

The Sperling is an older soil with a deeper "A" horizon, developed under prairie vegetation in the western portion of the Valley where the parent material is not so fine in texture as the soils in the centre of the Valley.

To obtain the soil samples used in this study of the nitrogen content of the tongued soil and the normal profiles, a pit was dug in the virgin soil in a representative portion of each of the above four series. At the time the pits were opened, pen and ink sketches of the tongues at the point of sampling were made from measurements. These are reproduced in Figure 1. A description of the profiles where the pits were excavated to obtain the soil samples follows.*

*It should be pointed out that the descriptions given are field observations of the pit walls and the colours noted are those observed under the moisture conditions prevailing.

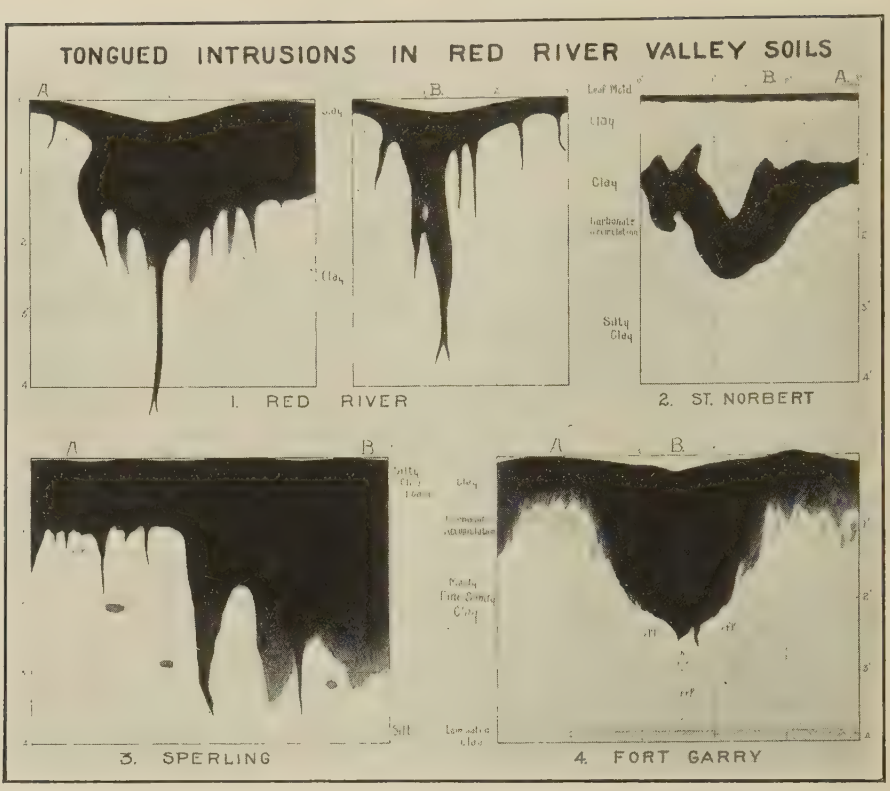

FIGURE 1. Pen sketches of tongued intrusion in Red River Valley soils. The sketches were made from observations and actual measurements when the pits were opened for sampling. The letters "A" and "B" mark the point below which the soil samples were taken.

(b) *Description of Profiles.*

1. RED RIVER VALLEY PROFILE

DEPTH IN INCHES	DESCRIPTION
0 to 2	Black clay mixed with organic debris, structureless to very finely granular, and filled with grass root mat. Neutral to slightly acid reacion.
3 to (8 or 10)	Very dark brown clay with a gray cast when dry; structure,—granular, irregular and slightly angular in shape, buckshot above, to wheat size below, permeated with grass roots mostly vertical and having a tendency to develop vertical cracks. When dry the granules readily break away from each other. When wet the granules swell and the horizon becomes compact and sticky. Neutral in reaction, but will not effervesce with acid. Black tongues penetrate both this horizon and the lower horizons from above in thin vertical tongues, sharp in outline where recent intrusions of surface material has taken place, or as wider patches in the older tongues in which the black colour grades into the dark brown adjacent material. These intrusions are black in colour, finely granular, and in marked contrast to the coarser granules of the dark brown clay into which they intrude. The darker intruded material is more friable and less sticky.
(8 or 10) to 18	Grayish brown clay in irregular glazed granules of pea size, which are aggregations of smaller granules closely packed, and with a tendency to form weak prismatic clods 1 by 2 inches. Dark intrusions continuous with those in the above horizon are numerous. Effervescence with acid is obtianed below 10 inches except in the intruded black tongues.

Depth in Inches	Description
18 to 28	Grayish brown clay with weakly developed structure, wheat to pin-head in size, compact, plastic, and containing numerous pieces of decomposing grass roots and innumerable pin holes where decayed roots have disappeared.
29+	Slightly mottled olive gray to olive drab clay, mottled with yellowish gray calcareous concretions. The structure is curved platey granules with shiny faces. Round well preserved pin-like root holes and live roots are present extending to the depth examined. This grades into the laminated lacustrine clays of Lake Agassiz which is the parent material of the series.

2. Fort Garry Profile

The virgin surface of the Fort Garry series is markedly hummocky. The difference in soil profile due to the broad nature of the tongues below the rifts between the hummocks is so marked that the description is given under the heading of "Normal" profile and Tongued intrusions. (See also Figure 4).

NORMAL PROFILE

Depth in Inches	
0 to 1½	Well decomposed dark brown organic material mixed with black silty clay filled with a mat of sod roots.
1½ to 4	Black clay in buck-shot size granules, crumb shaped dull faced and closely packed, stiff and stubborn, breaking into vertical cracks when dry.
5 to 7	Gray black clay similar in structure to above horizon but with slightly larger granules which have a glassy lustre. The gray colour increases from above downwards. This horizon is irregularly joined with the underlying one.
8 to 12	An irregularly tongued streaked carbonate accumulation horizon of silty clay, mottled gray above and yellowish gray below. The gray and yellow colour is streaked with dark gray and grayish black vertical streaks, at the edges of and between which a marly accumulation is observed. The horizon has only a weakly developed structure, it is crumbly, friable and highly calcareous.

TONGUED INTRUSION

Depth in Inches	
0 to 3½	Similar to normal, but of greater depth and more peat like.
3½ to 4½	As in normal, 1½ to 4 inches.
4½ to 25	Finely granular black clay with gray cast when dry, formed from the intrusion of surface material. The first 4½ to 7 or 8 inches shows very dark brown gray colouring where modification is not so complete, and with a tendency to break into pillared cracks when dry. The lower portion, 8 to 25 inches, is very uniform black clay with shiny granules, buck-shot to wheat size, closely packed and sticky.
26 to 29	An undulating carbonate accumulation horizon similar to that found at 8 to 12 inches in the normal profile extends immediately under the funnel-shaped black tongues. This effervesces fiercely with acid. At the lowest point of the undulation, however, a 3-inch wide vertical strip has been leached of its carbonate and the soil at this point will not effervesce until a point 8 inches below the tongue is reached. (See Figure 1).

Depth in Inches		Depth in Inches	
13 to 28	Buff coloured very fine sandy clay weakly indurated, crumbling to very fine sandy feel when dry, and of the consistency of putty when wet. Yellow brown and dark brown iron eyes or specks give a speckled appearance to the lower portion of the horizon.		
29 to 45	Light buff coloured fine sandy clay with thin lenses of gray clay giving it a laminated appearance, richly speckled with iron eyes or dots, brown to yellow in colour. Numerous pin-holes where roots have decayed are well preserved.	30 to 45	As in normal profile 29 to 45.
46+	Olive gray to olive drab laminated lake clay, more or less stained brown with iron in upper portion, compact, tough, closely packed, breaking into angular shaped granules which show convex laminations. This grades into laminated lake clay with interlayers of fine whitish layers of gypsum. Concretions of carbonate and sulphate are plentiful in upper portion.	46+	Same as in 46+ Normal.

3. St. Norbert Profile—(*Woodland invasion of prairie*).

Depth in Inches	Description
0 to 2	Leaf mould, well preserved.
2 to 2¾	Grayish black, finely granular clay mixed with finely divided organic material.
2¾ to 5	Whitish gray clay, wheat to pea size granules, irregular in shape, dull and lustreless. When examined, granules were dry, loose and strongly acid in reaction.
6 to 14	Grayish brown clay with dark streaks, structure shows small clods, 1 cm. in size, made up of aggregates of small closely packed wheat sized granules, tough and hard to dig and breaking into clods with irregular cleavage. Acid reaction.
15 to (24 or 36)	Irregular horizon of black coloured clay, similar in appearance to "A" horizon of the adjacent prairie. Irregular tongues of grayish brown penetrate into this dark horizon from above, and the lower junction is tongued as in the adjacent prairie. The black clay is finely granular with glassy surfaces, compact and moderately tough. The grayish brown clay tongues are similar in structure but not so tough and are more plastic. The black portion is neutral to slightly acid in reaction. The gray brown portion is acid.
24 to 28 or 36 to 40	A 4-inch undulating horizon forming a junction between the upper tongued horizon and the underlying material of olive gray clay, finely granular, closely packed and effervesces with acid in the lower portion.
28 or 40+	Mottled, marly, silty clay, olive drab to yellowish gray in colour, finely granular with soft white concretions of calcium carbonate.

4. Sperling Profile

Depth in Inches	Description
0 to 2	Sod mat mixed with organic debris and very dark grayish brown to black silty clay loam.
3 to 5	Very dark brown silty clay loam with grayish cast when dry. Finely granular structure.
6 to 11	Very dark brown friable silty clay loam with grayish cast in small clods half to one inch in diameter, but cracking with vertical cracks when dry. Fissures between the granules and vertical columns contain particles of very fine sand.
11 to 23	An irregular, highly calcareous concentration horizon gray brown silty clay above to gray silt below, with very dark brown to black tongued intrusions from upper horizon. These dark tongues may be fine streaks filling the root cracks, or broad intrusions. In the pit sampled the black tongues varied from one to three inches wide to broad patches three feet or more in width. These intrusions show all degrees of density of colour from black to light gray, as though former intrusions had faded out. In the normal horizon the granules are buckshot to wheat size and slightly sticky. In the dark intrusions the granules are wheat to pea size with a tendency to form prismatic clods one by one and a half inches. Effervescence with acid is obtained at 11 inches, except in the dark tongues, in which case effervescence occurs immediately below the dark material.
23 to 34	Light brownish gray silt, highly calcareous, mottled with lime concretions, friable and easily disintegrated. Gopher burrows filled with black surface material are abundant.
35+	Buff sandy clay with lenses of gray clay speckled with yellow brown specks. It contains many minute root-made pores and has only weakly developed structure.

Nitrogen Determinations of Tongued and Normal Profiles

To obtain the samples for analysis of the nitrogen content of the tongued and not tongued portions of the soils used in this study four pits were dug in the virgin soil, one pit in a representative portion of each of the four series. A point was selected in the pit wall showing three storied horizon development, which was considered to be the normal profile, and a second point was selected which showed the well developed tongued intrusion of the black material. From each point a series of samples was collected by three inch depths from the surface downwards. These three inch sections were cut square from a vertical column. They were placed in containers and taken to the laboratory for nitrogen determination. The total nitrogen in the samples was determined by the modified Gunning-Hibbard Kjeldahl method. The moisture equivalent of each sample was determined in duplicate also, and the figures are included along with the nitrogen analysis table. The results secured are shown in Table 4, which shows the moisture equivalent, the total nitrogen content and the ratio of the total nitrogen content in the tongued intrusion to that in the normal profile.

The figures in Table 4 bring out very emphatically the higher nitrogen content of the deep tongued intrusions when compared to that of the normal profiles. In the case of the Fort Garry sample the nitrogen content of the first three inches of the second foot in the tongued intrusion was over eight times as high as the corresponding level in the normal profile. It is also evident that the nitrogen content of the surface may vary to a marked degree. In the case of the surface three inches of the Fort Garry soil the difference

TABLE 4.—*Total nitrogen and ratio of total nitrogen in tongued profile to total nitrogen in normal profile in Red River Valley soils (Nitrogen percentage given on water free basis)*

Depth in Inches from surface	Moisture Equivalent		Percent Total Nitrogen		Ratio of total Nitrogen in Tongued Intrusion to the Normal
	Normal Profile	Tongued Intrusion	Normal Profile	Tongued Intrusion	
RED RIVER PROFILE					
1 to 3	57.7	56.0	.796	.814	1.02
4 to 6	48.5	53.8	.302	.773	2.55
7 to 9	46.7	53.6	.236	.775	3.28
10 to 12	47.4	52.4	.205	.720	3.51
13 to 15	46.1	51.4	.171	.720	4.21
16 to 18	46.0	49.2	.161	.624	3.87
19 to 21	46.8	48.4	.148	.553	3.73
22 to 24	46.9	49.3	.133	.454	3.41
25 to 27	48.4	49.6	.135	.391	2.89
28 to 30	48.9	50.3	.142	.308	2.16
31 to 33	48.4	49.7	.121	.261	2.15
34 to 36	46.2	48.3	.096	.249	2.59
37 to 39	45.4	47.6	.083	.191	2.30
40 to 42	44.8	46.6	.074	.160	2.16
43 to 45	46.3	47.5	.066	.149	2.25
FORT GARRY PROFILE					
1 to 3	44.8	53.9	.650	1.034	1.59
4 to 6	36.5	38.6	.212	.915	4.31
7 to 9	33.2	33.8	.129	.405	3.13
10 to 12	29.9	36.0	.092	.507	5.51
13 to 15	25.5	37.7	.060	.503	8.38
16 to 18	22.3	38.5	.039	.216	5.53
19 to 21	20.7	37.2	.069	.207	3.00
22 to 24	20.5	32.4	.083	.157	1.89
25 to 27	22.0	22.5	.075	.063	.84
28 to 30	19.9	17.3	.024	.017	.70
31 to 33	15.9	17.1	.044	.015	.34
34 to 36	16.2	17.2	.046	.015	.32
ST. NORBERT PROFILE					
Leaf Mold			1.667	1.664	
1 to 3	41.7	41.3	.571	.508	.88
4 to 6	34.2	35.2	.250	.182	.72
7 to 9	40.7	38.2	.195	.183	.93
10 to 12	52.0	39.7	.120	.217	1.80
13 to 15	56.9	39.5	.109	.215	1.97
16 to 18	41.6	43.1	.064	.202	3.15
19 to 21	40.0	46.4	.062	.167	2.69
22 to 24	39.4	52.0	.070	.127	1.81
25 to 27	38.0	51.5	.075	.110	1.46
28 to 30	38.9	48.6	.074	.086	1.16
31 to 33	37.7	46.2	.070	.082	1.17
34 to 36	38.3	44.9	.068	.071	1.04
37 to 39	37.9	41.5	.063	.073	1.15
40 to 42	37.4	38.8	.058	.061	1.05
43 to 45	36.9	38.1	.053	.061	1.15
46 to 48	36.6	37.2	.051	.056	1.09
SPERLING PROFILE					
1 to 3	44.5	39.3	.663	.540	.81
4 to 6	45.5	39.5	.638	.532	.83
7 to 9	35.0	37.4	.295	.453	1.53
10 to 12	29.5	37.7	.177	.456	2.57
13 to 15	27.6	35.3	.140	.331	2.36
16 to 18	27.0	34.2	.116	.239	2.06
19 to 21	27.7	33.8	.098	.192	1.95
22 to 24	28.6	33.6	.086	.167	1.94
25 to 27	29.2	34.3	.078	.162	2.07
28 to 30	25.3	33.9	.062	.151	2.43
31 to 33	29.5	33.5	.064	.138	2.15
34 to 36	30.1	33.7	.066	.134	2.03
37 to 39	31.8	33.0	.067	.115	1.71
40 to 42	19.9	30.0	.039	.092	2.35
43 to 45	18.1	28.6	.031	.069	2.22
46 to 48	23.1	21.7	.035	.041	1.32

is .650 per cent in one case and 1.034 per cent in the other. This, however, is easily explained by referring to the profile descriptions which show that in the virgin condition, the rifts between the hummocks have a greater depth of peat-like material mixed with the surface soil.* This is evidenced also in the moisture equivalent figures.

Field Observations re Tongued Intrusions and Hummocks

Field observations bring out a few points which should be taken into consideration in connection with the figures in Table 4. The pen sketches of the profiles reproduced in Figure 1 show that the black tongues in the Fort Garry profile are broad and undulating, but generally less deep than in the other soils, while those of the Red River soils are comparatively deep and resembling icicles in shape. In the Sperling profile the tongues are variable but generally they are deep and intermediate in shape between the sharp pointed intrusions of the Red River and the broad undulations of the Fort Garry; however, they also merge into each other and present broad deep intrusions as much as three feet or more wide and three feet deep. The St. Norbert soil is of a different nature. The dark tongues which are only observed as an irregular horizon some distance below the surface were formed when this soil was prairie, but due to the woodland development and consequent change in the type of soil weathering, the surface soil has changed from black to gray and grayish brown; the black colour in this case does not extend to the surface.

Figure 2. Topography, native vegetation and hummocky condition of surface of Fort Garry series. Both the blue grass (*Poa pratensis*) of the foreground and the young poplar (*Populus tremuloides*) in the background are recent vegetative invasions. The hummocky condition is shown under the measuring stick at the surface of the pit.

*It is probably intruded surface organic material of this kind which Lawes and Gilbert found mixed with the soil examined by them, and which they picked out as well as possible before analyzing the samples.

TABLE 5.—*Monthly rainfall at Winnipeg during the growing season 1872 to 1927.*

Year	Previous total winter precipitation Nov.–March	April	May	June	July	August	September	October	Total seasonal precipitation April–Oct.
1872		5.42	3.80	3.80	1.62	1.85	8.09	1.55	26.13
1873	2.93	.92	2.38	3.37	3.55	1.17	2.28	.54	14.21
1874	3.04	.56	2.01	4.38	3.21	3.77	2.04	.63	16.60
1875	3.02	.67	3.34	3.45	1.76	4.88	.86	1.38	16.34
1876	5.66	.46	3.05	4.50	3.31	9.42	1.36	.66	22.76
1877	4.88	1.28	5.39	5.69	3.24	.83	3.02	.78	20.23
1888	6.92	3.98	3.76	3.99	5.47	1.53	1.80	3.18	23.71
1879	4.58	2.24	2.78	6.98	5.22	1.82	.72	1.38	21.14
1880	6.22	.45	5.88	3.52	2.74	4.06	4.13	1.72	22.50
1881	6.18	.76	2.07	2.66	.87	1.82	2.60	1.50	12.28
1882	8.75	.47	1.58	1.45	7.10	1.51	1.01	3.79	16.91
1883	4.68	1.02	1.35	3.48	1.77	2.96	1.96	3.68	16.22
1884	5.35	2.69	.87	2.97	1.32	6.91	3.75	1.52	20.03
1885	3.83	1.82	1.94	3.05	2.65	1.99	.74	.59	12.78
1886	3.55	1.73	1.19	1.20	.67	1.17	4.75	1.22	11.93
1887	3.67	1.14	3.01	2.94	2.02	1.49	1.77	.45	12.82
1888	4.59	1.29	.18	3.10	3.88	1.13	1.49	2.70	13.77
1889	3.87	.85	1.79	.45	2.38	.95	2.67	.86	9.95
1890	4.98	1.20	2.10	2.46	5.61	3.05	3.06	3.67	21.15
1891	2.93	1.13	.93	4.72	1.94	3.90	2.20	1.05	15.87
1892	4.92	2.55	1.85	1.40	3.57	3.73	.86	.84	14.80
1893	5.99	2.30	2.23	3.87	5.42	1.52	.66	1.35	17.35
1894	6.48	3.56	.58	2.40	.63	.77	2.18	1.79	11.91
1895	5.71	.62	3.74	2.31	3.33	1.01	1.14	.33	12.48
1896	4.47	5.64	5.32	3.96	2.01	1.51	1.96	1.01	21.41
1897	4.94	1.01	1.59	2.31	5.38	1.00	.34	1.33	12.96
1898	5.79	.98	.89	6.10	1.77	2.15	2.50	5.67	20.06
1899	5.58	2.17	2.20	3.68	1.96	3.42	.91	1.85	16.19
1900	2.59	.30	.11	1.85	4.06	3.66	4.22	.94	15.14
1901	3.48	1.93	.36	10.07	3.12	1.70	3.80	.46	21.44
1902	4.03	1.33	3.87	3.46	1.33	.93	2.01	1.23	14.16
1903	5.98	.54	3.40	.49	3.05	2.00	2.77	.69	12.94
1904	6.54	.46	1.77	4.22	5.55	1.62	1.88	1.51	17.01
1905	4.22	.25	3.35	4.62	4.35	1.41	1.56	1.03	16.57
1906	3.62	1.64	2.97	6.30	3.37	1.33	1.51	.21	17.33
1907	6.64	.99	.97	1.54	3.98	3.90	.69	.40	12.47
1908	4.97	1.75	3.01	3.11	1.76	2.44	1.89	2.21	16.17
1909	5.36	1.58	1.25	1.54	3.84	4.75	.60	.52	14.08
1910	8.34	1.49	1.65	2.38	.80	2.14	2.75	1.08	12.29
1911	4.56	2.57	6.38	2.27	2.96	2.53	2.43	1.84	20.78
1912	1.96	2.25	3.59	.91	6.11	1.64	5.49	1.15	21.14
1913	2.61	.41	.53	3.27	2.09	4.71	1.27	.77	13.05
1914	3.22	.75	1.65	1.46	7.14	2.05	2.28	2.22	17.55
1915	3.67	1.31	.82	2.56	1.83	.13	4.89	1.03	12.57
1916	8.59	.30	2.47	4.12	2.84	2.35	2.03	2.32	16.43
1917	4.33	.22	.03	2.13	3.27	1.70	1.93	1.36	10.64
1918	3.12	1.32	.81	3.74	1.99	3.18	.62	1.09	12.75
1919	6.69	1.11	1.91	4.95	3.83	3.15	3.20	1.64	19.79
1920	6.78	.30	1.51	3.40	.76	1.45	3.33	.21	10.96
1921	7.04	1.86	1.76	1.56	3.71	2.46	3.63	.93	15.91
1922	3.71	.52	2.65	2.28	4.95	1.35	3.01	.51	15.27
1923	7.78	.73	2.55	1.47	3.55	.65	1.09	.50	10.54
1924	2.11	3.49	.40	1.13	2.99	1.37	3.64	2.70	15.72
1925	6.01	1.12	.29	2.37	.61	2.99	2.37	1.34	11.09
1926	2.50	.16	.83	3.53	2.01	3.23	3.76	3.03	16.55
1927	3.22	2.43	4.70	1.79	1.14*	2.95*	3.12*	3.32*	21.15

*Records from Manitoba Agricultural College Observatory, Winnipeg.

Along with the variations in the form of the black tongues, the variations in the hummocky conditions of the surface of the virgin land were observed. In the Fort Garry series the hummocks are well developed and are markedly characteristic and the rifts are coincident with the tongues below. In the Red River series the hummocks may be noticed also but they are more shallow, while in the Sperling they are hardly noticeable. All these soils were developed under the same atmospheric climate; therefore, variation in the nature of the tongued conditions of the three grassland soils—Fort Garry, Red River and Sperling—must be due to other causes.

Relation of Climate to the Tongued Intrusions

In order that a correct understanding may be obtained of the prevailing climatic conditions over a long period, the weather records of the Dominion Meterological Service (*4*) for the Winnipeg recording station have been compiled and they are submitted. Table 5 shows the monthly rainfall at Winnipeg during the growing season for fifty-six years and Table 6 shows the maximum, minimum and mean monthly temperatures during the growing season for fifty-three years. The months in which the mean monthly temperature is above freezing, that is the growing months, are April to October inclusive, and to indicate the average climatic conditions the mean figures for temperatures and rainfall for these months are summarized in Table 7.

During the months November to March, the mean monthly temperature is below freezing and the soil is frozen so that there is no plant growth to dry the soil. During these months the precipitation is usually snow. Table 7 shows that the highest monthly rainfall usually occurs in June and the highest monthly temperature in July. The rainfall has the characteristic of Western prairie precipitation. The mean rainfall for the growing period, April to October, is 16.15 inches for the fifty-six year period 1872 to 1927, which, with the temperatures which prevail, results in the remarkable growth for which this area is famous. The figures in Table 5, however, show that seasons and periods occur in which the precipitation is so limited that dry weather is experienced during the summer and fall months. When these dry periods occur, the active use of soil water by plants causes the shrinking and cracking of the heavy textured soils of the Valley and this permits the wind and subsequent rains to wash surface material into the cracks, and the dark tongued intrusions of surface material in the underlying horizons are the result.

Table 7.—*Mean monthly precipitation and mean monthly temperature at Winnipeg for the months in which the temperature is above freezing.*

Month	Mean Monthly precipitation 56 year avg.	Monthly temp. 53 year avg. in degrees F.		
		Maximum	Minimum	Mean
April	1.464	49.04	26.96	38.01
May	2.203	64.74	39.21	51.98
June	3.155	74.27	50.09	62.17
July	3.060	78.39	54.50	66.43
Aug.	2.408	75.94	51.13	63.52
Sept.	2.368	65.45	42.48	53.97
Oct.	1.486	51.04	30.96	41.01

TABLE 6.—*Monthly temperature at Winnipeg during the growing season in degrees Fahrenheit.*

Year	April			May			June			July			August			September			October		
	max.	min.	mean	max.	min.	mean	max.	min.	mean	max.	min.	mean	max.	min.	mean	max.	min.	mean	max.	min.	mean
†1875–84	45.6	23.4	34.5	64.4	40.1	52.3	73.1	49.3	61.2	78.2	53.6	65.9	76.2	51.5	63.9	63.3	40.6	52.0	48.3	28.1	38.2
†1885-94	48.0	25.9	37.0	62.9	36.3	49.6	76.1	50.0	63.0	78.0	53.5	65.7	75.3	48.8	62.0	65.3	40.9	53.1	50.5	29.4	40.0
1895	62.1	32.6	47.3	67.3	40.8	54.0	69.5	47.6	58.5	75.8	51.7	63.7	74.8	48.1	61.4	64.8	39.0	51.9	50.5	26.1	38.3
1896	45.0	27.1	36.1	65.7	44.5	55.1	74.6	53.4	64.0	75.9	53.7	64.8	74.8	48.0	61.4	62.0	38.4	50.2	48.7	26.4	37.6
1897	51.0	28.4	39.7	67.8	38.3	53.1	72.1	46.4	59.3	79.0	56.8	67.9	73.4	49.8	61.6	76.1	46.1	61.1	55.2	34.0	44.6
1898	51.3	25.3	38.3	68.5	37.9	53.2	71.7	49.0	60.3	77.4	54.0	65.7	74.8	51.1	63.0	67.3	43.9	55.6	45.0	30.5	37.7
1899	48.4	25.1	36.7	62.0	39.0	50.5	74.2	50.6	62.4	79.0	54.2	66.6	75.7	50.8	63.2	65.9	39.5	52.7	52.1	32.3	42.2
1900	64.2	31.6	47.9	74.2	40.4	57.3	81.4	51.2	66.3	78.1	51.7	64.9	79.4	55.4	67.4	63.6	43.6	53.6	56.8	35.3	46.1
1901	55.4	30.2	42.8	73.1	43.4	58.2	71.7	48.7	60.2	80.2	58.3	69.2	77.7	51.4	64.6	63.0	41.1	52.0	57.6	31.8	44.7
1902	48.5	26.1	37.3	65.9	44.2	55.1	67.1	46.9	57.0	80.0	55.7	67.8	77.6	50.9	64.2	65.0	40.7	52.8	53.3	30.5	41.9
1903	52.6	27.4	40.0	67.8	40.6	54.2	75.4	47.6	61.5	77.8	52.9	65.4	72.5	49.8	61.2	60.9	38.3	49.6	56.8	33.1	45.0
1904	44.0	26.2	35.1	67.3	39.7	53.5	71.7	50.5	61.1	74.4	52.2	63.3	72.5	49.6	61.0	62.1	40.8	51.5	51.8	35.3	43.6
1905	49.7	27.0	38.4	62.5	38.3	50.4	69.3	47.6	58.5	76.6	54.0	65.3	76.5	54.4	65.4	70.8	46.3	58.6	48.0	28.1	38.1
1906	60.3	33.6	47.0	61.6	36.2	48.9	75.0	52.4	63.7	77.5	56.3	66.9	77.1	53.1	65.1	74.7	46.9	60.8	52.7	30.8	41.7
1907	36.7	19.8	28.2	51.8	27.7	39.7	73.9	49.7	61.8	78.9	55.5	67.2	71.9	51.1	61.5	61.6	39.9	50.8	53.0	29.8	41.4
1908	51.5	28.5	40.1	64.5	39.9	52.2	73.1	51.0	62.1	79.7	54.1	66.9	74.2	50.0	62.2	70.1	46.6	58.3	51.2	35.3	43.3
1909	39.3	21.4	30.3	64.5	39.2	51.8	77.1	49.8	63.5	80.0	56.0	68.0	78.6	52.2	66.9	70.9	45.1	58.0	52.4	32.7	42.5
1910	55.6	30.2	42.9	62.5	35.4	48.9	82.0	54.8	68.4	81.9	55.6	68.7	75.5	49.0	62.2	65.2	43.4	54.3	57.4	36.1	46.8
1911	52.8	29.9	41.4	67.8	42.4	55.1	75.2	55.6	65.4	75.2	53.1	64.1	74.3	51.6	62.9	63.1	41.6	52.4	51.3	34.6	42.9
1912	52.4	30.0	41.2	64.7	42.4	53.6	78.3	50.7	64.5	75.5	55.1	65.3	70.0	50.5	60.3	61.9	44.8	53.4	54.0	33.6	43.8
1913	57.5	34.8	46.2	61.7	38.2	50.0	77.0	52.8	64.9	75.3	53.5	64.4	76.1	54.2	65.2	67.0	44.4	55.7	45.5	27.9	36.7
1914	45.3	26.9	36.1	68.0	42.4	55.2	75.3	51.0	63.1	83.9	60.6	72.2	74.3	51.2	62.7	67.8	46.2	57.0	61.6	40.4	51.0
1915	61.3	36.5	48.9	66.0	39.6	52.8	68.5	45.4	56.9	74.1	51.5	62.8	81.8	50.8	66.3	64.3	45.1	54.7	55.6	34.1	44.8
1916	47.	27.	37.0	61.	38.	49.5	69.	48.	58.5	83.	61.	72.0	76.	53.	64.5	64.	43.	53.5	45.	29.	37.0
1917	44.	26.	35.0	67.	35.	51.0	73.	46.	59.5	81.	57.	69.0	75.	52.	63.5	66.	45.	55.5	41.	26.	33.5
1918	55.	30.	42.5	62.	37.	49.5	73.	48.	60.5	77.	51.	64.0	77.	54.	65.5	61	36.	48.5	54.	34.	44.0
1919	52.	31.	41.5	72.	44.	58.0	80.	56.	68.0	81.	57.	69.0	78.	54.	66.0	66.	46.	56.0	42.	24.	33.0
1920	39.	20.	29.5	68.	41.	54.5	75.	51.	63.0	80.	53.	66.5	86.8	55.0	68.7	72.	48.	60.0	60.	38.	49.0
1921	47.	29.	38.0	67.	42.	54.5	79.	57.	68.0	82.	59.	70.5	76.	52.	64.0	66.	48.	57.0	55.	36.	45.5
1922	52.	31.	41.5	72.	48.	60.0	78.	52.	65.0	78.	55.	66.5	80.	55.	67.5	68	47.	57.5	54.	34.	44.0
1923	45.	23.	34.0	67.	42.	54.5	81.	54.	67.5	83.	60.	71.5	75.	50.	62.5	71.	47.	59.0	54.	33.	43.5
1924	44.	28.	36.0	57.	33.	45.0	71.	46.	58.5	77.	55.	66.0	74.	51.	62.5	66.	43.	54.5	60.	41.	50.5
1925	55.	35.	45.0	64.	38.	51.0	71.	51.	61.0	78.	55.	66.5	79.	56.	67.5	67.	45.	56.0	40.	26.	33.0
1926	50.	26.	38.0	70.	45.	57.5	68.5	49.1	58.8	80.1	55.8	68.0	75.1	53.5	64.3	60.1	42.8	51.4	46.8	32.3	39.5
1927	48.1	31.5	39.8	56.3	40.9	48.6	71.6	51.2	61.4	76.6	52.2	64.4	74.2	48.2	61.2	67.7	44.0	55.8	55.0	33.8	44.4
Mean			38.01			51.98			62.17			66.43			63.52			53.97			41.01

† Ten year average.

Relation of Parent Material to the Tongued Intrusions

Though the dark tongues are caused primarily by climatic factors the form of the tongues is dependent upon the physical properties of the profile material. Some of the soil scientists who examined the soil of the Fort Garry series during the First International Congress of Soil Science Field Excursion in 1927, insisted that these broad intrusions in the Fort Garry soils were the result of the filling of holes left where trees have been removed. This explanation, however, is not to be considered because the tongued Fort Garry series was not developed as a woodland soil. John Macoun (7), Dominion Botanist, in 1882 described the vegetation of the land where the Fort Garry series is found, as follows: "The Red River and its tributaries are fringed with trees, of which oak, elm, poplar and ash-leafed maple are the most evident.....Away from the immediate borders of the streams the prairie, though covered with a luxuriant sod, is absolutely treeless". This record, together with the examination of the normal profile, is sufficient to prove that the land was not wooded formerly.

Figure 3. Fort Garry soil profile photographed from the wall of the pit shown in Figure 2 which brings out clearly the hummocky condition of the surface and the coincidence of the tongues below the rifts in between the hummocks.

The authors submit that the presence of the relatively shallow broad black tongued intrusions of the Fort Garry series can be easily explained by the differential shrinkage of the profile material. The enormous shrinkage on drying, of soils high in colloids, is a well known phenomenon. With a uniform texture throughout the profile, such as is shown in the Red River series by the moisture equivalent figures in Table 3, it is to be expected that the cracks in the continuous clay profile, when drying occurs, would be deep and proportionate in width to the moisture reduction, except where it may be modified by concentration horizons. The long, relatively fine, icicle-like intrusions of dark material in the Red River series indicate that this is the case. In the Fort Garry soil, however, the profile material is

FIGURE 4. St. Norbert profile showing development of whitish A_2 horizon and the fading out of black surface colour due to woodland invasion on a prairie soil. The dark colour in the second foot of this profile may be seen in Figure 5. The line on photo marks the surface of the leaf mold.

not of a uniform texture. The Lake Agassiz clay, which is the parent material of most of the Red River Valley soils, is found only at the base of the soil profile in the Fort Garry series. In this series the laminated clay is covered with a marly very fine sandy clay deposit which usually occupies the second or third foot of the soil profile. This is again covered with a clay (or silty clay) which is generally only a few inches thick, but which may extend to a thickness of two or more feet when it occurs as a deeper phase. The geology of this bedded material is discussed in a very excellent series of papers by Wallace (*9, 10*) and his co-workers.

To illustrate the differential shrinkage in this upper black clay surface soil, and the underlying buff coloured marly very fine sandy clay, samples from the centre of each layer were obtained for laboratory examination. A sufficient amount of each soil was brought to the moisture equivalent in the moisture equivalent centrifuge machine, and two sets of four soil sample cans were filled, one set with each sample of the moistened soil. These cans were the usual four ounce soil moisture cans. Each can was packed as uniformly as possibly with a spatula and smoothed off on top. After the cans were filled they were set outside to air dry, in which condition, due to the manipulation in the filling of the cans, all samples were puddled and held together well. The measurement of shrinkage in drying from the moisture equivalent to air dry, was easily accomplished by filling the cracks with sufficient very fine dry sand, tapping the cans gently on the desk as the sand was added to work it into the cracks, and measuring the volume of the sand required to bring the cracks and the tins level full. The amount of shrinkage of the two lots of soil samples when the moisture was reduced from the moisture equivalent to "air dry" is given in Table 8.

TABLE 8.—*Percentage shrinkage of soil samples when moisture was reduced from moisture equivalent to air dry.*

Sample No.		Volume of can in cubic centimeters	Cubic centimeters fine dry sand required to fill shrinkage cracks in soil when air dry.	Volume shrinkage in per cent	Average shrinkage in per cent
FORT GARRY—					
Surface soil	1	122.0	32.5	26.63	
	2	122.0	30.5	25.00	
	3	122.0	30.5	25.00	25.33
	4	121.5	30.0	24.69	
FORT GARRY—					
Sub-soil	5	123.5	8.5	6.88	
	6	122.5	8.5	6.93	
	7	123.5	8.0	6.47	6.60
	8	122.0	7.5	6.14	

The moisture content of the samples reported in Table 8 was determined at the time the cans were filled. The cans and soil were weighed again when the soil was air dry and the moisture content of air dried soil was determined. The moisture figures obtained are given in Table 9.

TABLE 9.—*Moisture content of soil samples used in shrinkage experiment.*

Sample No.		Percent moisture content			Moisture lost in drying from the moisture equivalent to air dry	
		When cans were filled (M.Eq.)	When air dry			
Black Surface Soil	1		6.45		30.09	
	2		6.68	mean	29.86	mean
	3	36.54	7.07	6.75	29.47	29.79
	4		6.81		29.73	
Buff Sub-Soil	5		2.80		17.22	
	6		3.11	mean	16.91	mean
	7	20.02	2.67	2.91	17.35	17.11
	8		3.06		16.96	

Although only four shrinkage determinations of each sample were made, the comparison between each set is sufficiently uniform in comparison with the marked difference between the average of each set of samples that the figures can be taken to illustrate the remarkable difference in the shrinkage capacity of the two materials. These figures show that under the conditions of the experiment the ratio of shrinkage of the two layers is 1:3.83. While the soil in the cans may not act the same as undisturbed soil, it may be assumed that under field conditions the differential shrinkage would be sufficiently great that dark intruded surface clay would shrink and crack much more than would the material into which it was intruded. From the above figures and from field observations the following explanation of the peculiar shaped broad tongued intrusions of the Fort Garry series is submitted:

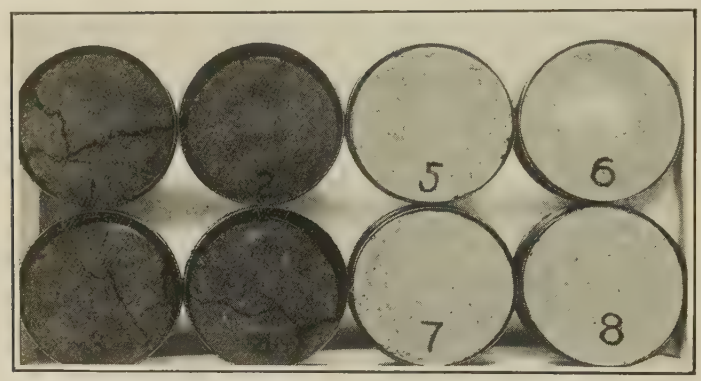

FIGURE 5. Differential shrinkage in Fort Garry soil. Samples 1, 2, 3 and 4 are surface soil; samples 5, 6, 7 and 8 are from the material into which the dark tongues are intruded. (See figure 3.).

Where the carbonate accumulation occurs, and weathering products from the "A" horizon modify the upper portion of the buff coloured sub-soil, cracking on drying will occur. When these cracks coincide with those in the upper dark coloured soil, surface material may be carried in by wind and rain. When the soil becomes wet, the wedged-in dark intruded material swells more than the adjacent material. Due to the plastic nature of the marly very fine sandy clay when wet, it reacts to the greater pressure developed by the intruded dark surface clay and heaving upwards takes place where the surface clay is the most thin. When the section again dries the contraction of the clay intrusion is greater than the adjoining material and more fissures open in the dark intrusions. This permits more material to enter from above, so that, with continual wetting and drying, the tongued portion tends to become wider by infiltration, and the surface soil at the crest of the hummocks tends to become thinner by erosion until the peculiar condition illustrated in Figure 3 results. From the field observations it is concluded that the downward growth of the tongues in this series is limited by the failure of the lower buff coloured stratified very fine sand and clay to develop vertical cracks in drying. Cracking appears to occur in the buff coloured sandy clay material only where the products of weathering

accumulate in its upper portion where it is in contact with the overlying black clay. Cracking in the continuous clay profile soils of the area, as in the Red River series, would be expected to be limited only by the depth to which it dries.

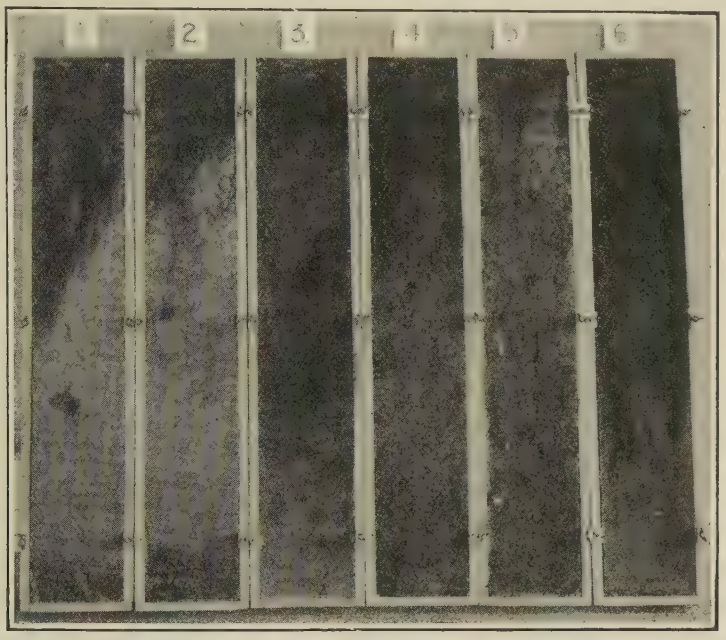

FIGURE 6. Monoliths of Red River Valley soil profiles. No. 1 and No. 2 are Fort Garry series. No. 3 is St. Norbert. No. 4 is Red River series. No. 5 is a meadow soil, the same parent material as No. 4 developed in the depressions. No. 6 is Sperling series. The Brunkild soil profile No. 5 has not developed deep tongues because it occupied a wet position.

SUMMARY

1. A reputation for high nitrogen content has long been ascribed to Red River Valley soils of Manitoba. The early work leading to this reputation is reviewed. The present work shows that the reputation is justified.

2. During a traverse across the Red River Valley to establish the soil types it was observed that all the soils examined were clay soils, and (with the exception of the soils of the depressions and wet meadow lands) all these soils showed dark intrusions of surface material extending from the surface into the underlying horizons.

3. The nitrogen content of these tongued intrusions, and that of the normal profiles, was determined from the analysis of vertical sections through the profiles of four different virgin soils. The total nitrogen content in the tongued intrusions was found to be higher than in the normal profiles.

4. The core of Selkirk soil analyzed by Lawes and Gilbert, which showed exceedingly high nitrogen content, is presumed to have been taken from tongued intrusions. Nevertheless evidence is given which shows the

tongued intrusions in the Red River soil series may have a higher total nitrogen content even than that reported by these authors.

5. The cause of the tongued intrusions in the Red River Valley soils is the cracking and opening up of the highly colloidal clay soils through shrinkage during relatively dry periods. These fissures or openings become filled with surface soil and organic material through the action of wind, rains, etc.

6. The dark tongued intrusions in these soils are shown to be of different forms, depending upon the physical properties of the soil material. A peculiar broad and relatively shallow type of tongued intrusion, co-existant with a highly developed hummock condition of the surface is shown to have been caused by differential shrinkage and expansion where the profile was composed of clay underlain by bedded very fine sandy clay.

7. The effect upon the crop due to the peculiar soil heterogeneity described requires investigation.

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LE VOYAGE D'ETUDE DU PREMIER CONGRES INTERNATIONAL DE LA SCIENCE DU SOL.

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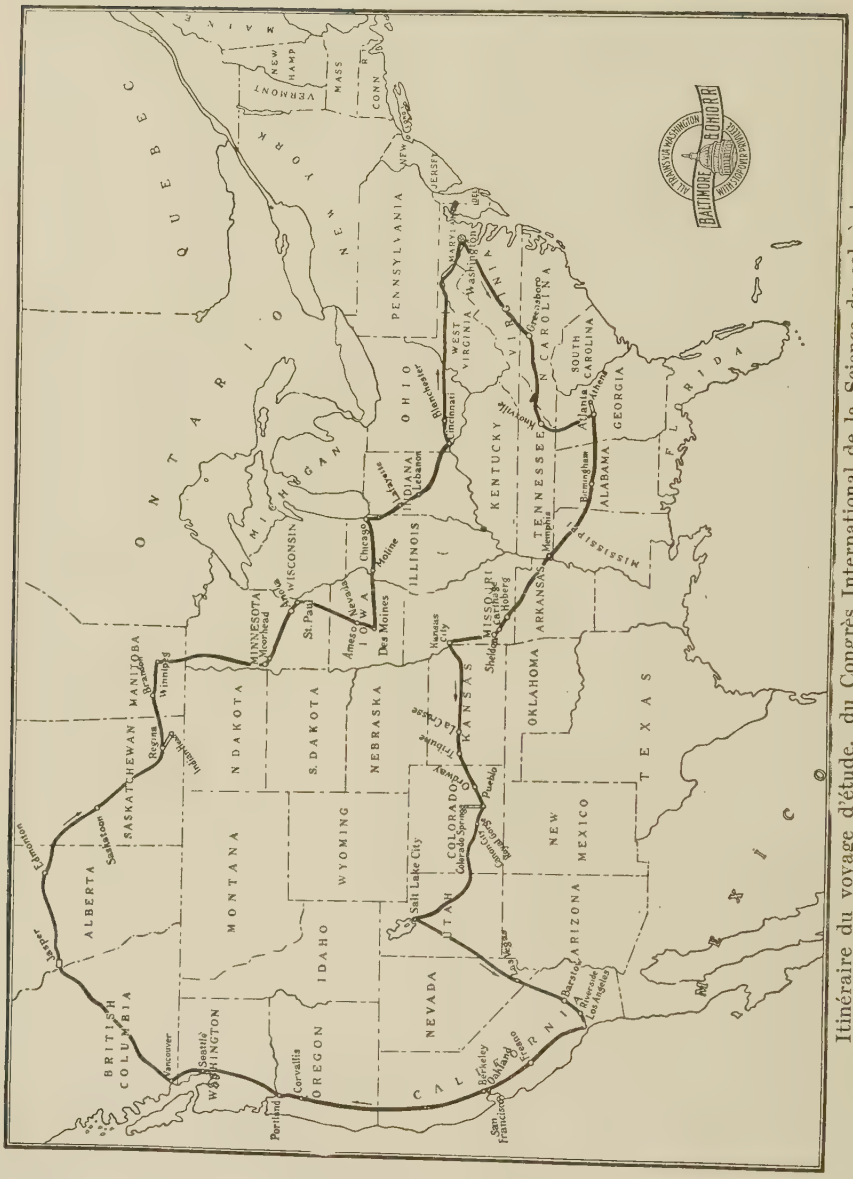
Le 22 juin, à 11 heures du soir, une foule de près de 250 congressistes se pressait dans la gare de Washington, aux abords d'un long train composé de 13 wagons dont neuf pullman et deux wagons-restaurant. Après quelques recherches, chacun finit par trouver l'alvéole qu'il devait occuper plus d'un mois durant dans la longue ruche roulante, prête à commencer son itinéraire de 10,000 milles à travers les grandes régions physiographiques qui s'étendent d'un océan à l'autre, pour y butiner des renseignements très variés, mais principalement des données concernant un grand nombre de profils de divers types de sols rencontrés. Rarement, je pense, un même pullman renferma dans ses flancs assemblage plus composite durant trente jours que le wagon baptisé du nom de "Demasby", qui me fut assigné par le sort. A ma gauche, je voisinais avec deux Polonais, en dessous avec un représentant de la Suède, tandis qu'en avant s'allongeait un savant hongrois; puis cela continuait avec des délégués d l'Allemagne, du Brésil, de la Suisse, de la Russie, de la Hollande, de la Tchékoslovaquie, etc.

Aussitot commença cette gymnastique de lézard, qui consiste à se faufiler à travers l'étroit couloir du pullman, avec la bonne volonté de gêner le moins possible les coöccupants chaque fois qu'il s'agit de se rendre à une extrémité du logement roulant, ou d'en revenir. Au bout d'un mois, on finit évidemment par acquérir quelque habileté dans cet exercice, et je découvre aussi que les circonstances qui m'obligent à parler alternativement l'anglais, le français, l'allemand et le hollandais me font tourner à espérantiste qu'on pourrait maintes fois surprendre construisant des locutions où des expressions tirées des quatre idiomes cherchent à s'harmoniser.

Itineraire General du Voyage

L'itinéraire de la grande randonnée était organisé méthodiquement de manière à passer à travers toutes les zônes climatiques des Etats-Unis et de l'ouest du Canada, et d'étudier ainsi les différents types de sols qui y correspondent, suivant les conceptions des méthodes russes de classification. Partant de Washington, notre convoi prit d'abord une direction générale sud-ouest, à travers les états de la Virginie, de la Caroline du Nord et du Tennessee, pour atteindre à Athens, où se trouvent situés l'université et le collège d'agriculture de Géorgie, le point le plus méridional du parcours. Cette partie du voyage s'effectua dans les trois provinces agrogéologiques principales qu'un aéroplane, abordant le continent américain par l'Atlantique, pourrait voir s'étager à partir de la côte et qui sont:

1o La Région de la Plaine côtière (*Atlantic coastal plain*), dans laquelle se trouve située la ville de Washington, point de départ, constituée d'alluvions marines grossières (graviers et sols sablonneux) déposées par les rivières dévalant des régions plus élevées à l'Ouest, dans la mer peu profonde qui submergeait la lisière orientale des Etats-Unis actuels, durant l'ère Tertiaire. Un relèvement récent du seuil continental qui s'avance assez loin dans l'At-



Itinéraire du voyage d'étude, du Congrès International de la Science du sol, à travers le Continent Américain.

lantique fit émerger les terrains de cette région formés entièrement de matériaux non encore consolidés où prédominent les éléments grossiers, ainsi qu'on vient de le dire. Immédiatement en arrière de la Plaine côtière, s'étend une région plus élevée, désignée sous le nom de Plateau du Piedmont (*Piedmont plateau*). Cette région constitute une véritable pénéplaine ondulée, découpée par des gorges profondes de 100 à 300 pieds. La limite du Piedmont avec la Plaine côtière est nettement marquée par un pli brusque ou une faille que l'on peut observer suivant une ligne partant des environs de New York et passant par les villes de Trenton, Philadelphie, Baltimore, Washington, Richmond, Raleigh et Macon.

WESTERN GLACIAL WESTLICHES GLACIALGEBIET
GREAT PRAIRIES GROSSE STEPPEN
CENTRAL PRAIRIE REGION CENTRAL STEPPEN GEBIET
EAST PRAIRIES OST-STEPPEN
RED PRAIRIES ROTE STEPPEN
HIGH PRAIRIES HOCH STEPPEN
EDWARDS PLATEAU
BLACK WAXY BELT SCHWARZES WACHSERDE
INTERIOR COASTAL PLAIN INNERE KÜSTEN EBENE
NORTHERN OZARKS NORDL OZARK GEBIET
SOUTHERN OZARKS SÜDL OZARK GEBIET
GLACIAL AND LOESSIAL LÖSS-GEBIET
GLACIAL AND GLACIAL UND
EASTERN GLACIAL ÖSTLICHE GLACIALGEBIETE
ALLEGHANY PLATEAU ALLEGHENY
SOUTHERN PIEDMONT SÜDLICHES PIEDMONT
MIDDLE COASTAL PLAIN
UPPER COASTAL PLAIN OBERE
FLAT WOODS
ROLLING SANDY LANDS HÜGELIGE SAND GEBIETE
EVERGLADES

PROVINCES AGROGEOLOGIQUES DE L'EST ET DU CENTRE DES ETATS-UNIS

A.—Plaine côtière de l'Atlantique et du Golfe.
B.—Plateau du Piedmont.
C.—Montagnes et Plateau des Appalaches.
D.—Vallées et hauteurs calcaires.
E.—Régions glaciaires et loessiennes.
F.—Plaines de débordement des rivières.
G.—Grandes plaines.
(Cliché reproduit de "Die Ernährung der Pflanze.")

Cette dislocation se trahit partout par une dénivellation ou palier plus ou moins accentuée que les cours d'eau, du Piedmont à la Plaine côtière, sont obligés de franchir par des cascades ou des rapides qui fournissent de l'énergie hydraulique aux nombreuses villez industrielles qui ont pris naissance le long de cette ligne de démarcation.

Les roches qui apparaissent à la surface du Plateau de Piedmont sont donc généralement de formation très ancienne, ayant jadis été enfouies à de grandes profondeurs pour ne réapparaitre au jour qu'après une longue période d'érosion. Ceci nous explique la prédominance des roches cristallines, représentées par des gneiss, des schistes cristallins, des ardoises, des roches éruptives, etc.

D'une altitude généralement plus élevée encore que le Plateau du Piedmont, lequel, ainsi que son nom l'indique, en forme les contreforts, nous

avons la grande région du Plateau et des Montagnes Appalaches, représentant toute la portion ouest du versant Atlantique du continent américain. Cette province physiographique se sépare d'ailleurs naturellement en plusieurs subdivisions ou zones longitudinales possédant une direction nord-sud, qui sont:

1o *Le Blue ridge,* à l'est, série de crêtes qui commencent approximativement à la rivière Hudson pour s'allonger jusque dans le nord de la Géorgie. Ce nom de Blue Ridge fut donné par les colons qui peuplèrent en premier lieu la Plaine côtière et pouvaient contempler, limitant l'horizon à l'ouest, la crête des Appalaches sous forme d'une ligne de hauteurs aux tons bleuâtres.

2o La Vallée des Appalaches, ou Grande Vallée, longue bande de territoire déprimée en forme d'auge, courant parallèlement à la Blue Ridge et s'étendant sur une longueur d'approximativement 1000 milles depuis Albany, au nord, jusque dans l'Alabama, au sud.

Les roches qui sont à la base de cette région sont d'une façon prédominante calcaires et schisteuses, et c'est donc à leur moindre résistance à l'action érosive qu'il faut attribuer la topographie générale de la vallée des Appalaches qui sépare les crêtes du Blue Ridge de la Partie le plus occidentale du système des Appalaches représentée par: 3o Le Plateau des Alléghanys et

4o Le Plateau de Cumberland, régions d'une altitude moyenne beaucoup plus élevée, dépassant parfois les 4000 pieds.

Les sols étudiés au cours de cette première partie de l'itinéraire présentent les caractéristiques propres aux climats chauds et humides, et cela d'une manière d'autant plus prononcée que l'on progresse davantage vers le sud. Nous en dirons quelques mots dans un paragraphe traitant des profils étudiés.

A partir d'Atlanta (Géorgie) le train spécial piqua en plein vers l'Ouest, pour traverser sans arrêt les états d'Alabama et de Mississippi. Dans ce dernier, nous franchimes d'abord la grande bande de *loëss* (sol éolien) qui se détachant des grandes étendues de cette même formation que l'on trouve plus au nord, recouvrant une partie des états du Middle-West, descend vers le sud, parallèlement à la vallée du Mississippi, jusqu'au golfe du Mexique.

Ensuite nous tombames dans la fameuse plaine alluviale du Mississippi, qui fut franchi à Memphis (Etat de Tennessee) pour passer dans l'état d'Arkansas, où, pendant des heures, notre train circula à travers une partie inondée de la vallée du grand fleuve en se maintenant sur les hautes levées ou remblais de terre qui mettent les voies ferrées et les routes principales hors de l'atteinte des eaux.

Abordant alors le Plateau de l'Ozark, région qui s'élève jusqu'à deux milles pieds d'altitude et dont la base est constituée en majeure partie de calcaires d'âge paléozique, noous filames dans une direction nord-ouest, à travers les belles régions agricoles de l'état de Missouri, pour atteindre la ville de Kansas, située sur le grand affluent du Mississippi. Ici nous nous trouvions au point le plus central de la grande république américaine, dans cette florissante cité du "Middle-west", qu'entourent les fameuses régions de production du blé et du maïs, et qui possède, après Chicago, les plus vastes cours à bestiaux du monde. De ce territoire aux formations loëssiennes

fertiles, terres classiques pour la culture des céréales, nous continuames toujours plus à l'ouest, rencontrant des conditions climatiques graduellement plus sèches dont la répercussion sur les types de sols se traduit par l'apparition des terres noires ou terres de steppes, auxquelles firent suite les sols salins et semi-arides du Colorado, où l'insuffisance des précipitations atmosphériques nécessite la mise en oeuvre des méthodes de dry-farming, ou de vastes systèmes d'irrigation dont il nous fut donné de voir un bel exemple dans la région de Rocky-Ford (Colorado), laquelle se distingue par une culture très intensive grâce à la fécondité qu'y apportent les eaux diverties de la rivière Arkansas qui s'alimente dans les Rocheuses, à l'ouest. Ce district forme, notamment, un des importants centres de culture de la betterave à sucre, de la luzerne et de toutes sortes de légumes destinés aux fabriques de conserves des Etats-Unis. Plus loin encore, avant d'atteindre Colorado Springs, endroit pittoresque situé au pied d'un des plus hauts sommets de la Cordillère, le Pikes Peak, dont les arrêtes de granit rouge pointent vers le ciel à 14,200 pieds au dessus du niveau de la mer, nous atteignons une région aride, ayant déjà un caractère désertique, lequel ne fit que s'accentuer lorsque nous pénétrames dans l'état d'Utah après avoir parcouru une série de canyons dont le plus remarquable est celui creusé par la rivière Arkansas dans un massif granitique, portant le nom de "Royal Gorge". La voie du chemin de fer de la compagnie Denver Rio Grande and Western, serpente au fond de cet étroit couloir, passant à certains moments au dessus des eaux torrentueuses, sur un pont suspendu entre les deux parois de roche rouge qui s'élèvent à pic à plus de 2000 pieds au dessus du niveau de la rivière.

Plus loin, le train franchit la crête de séparation des eaux des versants Atlantique et Pacifique, au Tennessee Pas, lequel s'élève à une altitude de 10,240 pieds, pour descendre à l'ouest de celui-ci dans la vallée de la rivière Colorado qui va se jeter dans le golfe de Californie après avoir traversé le fameux Grand canyon de l'état d'Arizona. Puis, quittant cette vallée, nous escaladons un autre plateau dans une direction nord-ouest pour redescendre enfin dans l'immense région déprimée que représente le Grand Bassin, au fond occupé par le Grand lac salé, vestige d'une nappe d'eau beaucoup plus vaste qui couvrit naguère la majeure partie du territoire actuel de l'Utah, et à laquelle les géologues ont donné le nom de Lac Bonneville.

Pendant longtemps, la voie du chemin de fer passe sur les anciens deltas et terrasses alluvionnaires qui marquent les diverses étapes de récession de cette mer intérieure disparue, puis la ville de Salt Lake City, avec son majestueux capitole, ses temples et autres grands édifices apparait comme une vision biblique au bas du grandiose amphithéatre, sur le fond de grisaille que lui forment les pentes arides des monts Wasatch surgissant circulairement dans la vaste dépression dont le centre est occupé par la surface miroitante du lac aux eaux saumâtres. Cette nature impressionnante dans sa sévère grandeur doit être certainement pour quelque chose dans le mysticisme bizarre et souvent puéril caractérisant la secte des Mormons qui fonda la ville de Salt Lake City, vers le milieu du siècle dernier, et transforma ses abords désolés en un oasis de verdure grâce à l'application de leurs méthodes ingénieuses d'irigation.

On ne peut songer, en effet, à la culture sans irrigation dans cette région du Grand Bassin où les précipitations atmosphériques n'atteignent que quelques pouces annuellement. Aussi la population agricole de l'Utah est-elle fort clairsemée, se bornant aux groupements qui cultivent les surfaces irriguées des environs de Salt Lake City et de quelques autres centres où on utilise les eaux des rivières qui s'alimentent aux hautes altitudes jouissant d'un climat humide. Avec ces conditions de climat aride et semi-aride, nous rencontrons évidement aussi les types de sols salins et alcalins qui en sont la conséquence naturelle. On ne s'arrête pas à Salt Lake City sans aller prendre un bain dans le fameux lac dont les lourdes eaux, qui accusent une teneur de plus de 24% de matière saline dissoute, représentée presque entièrement par du NaCl, vous portent comme des bouchons. La ville des Mormons avec ses grandes avenues plantées d'arbres, son capitole décoré de marbres précieux et ses riches monuments qui témoignent de la prospérité dont jouit l'Utah grâce à ses ressources minières, consistant principalement en argent, plomb, cuivre et or, mérite également une visite. Après l'inévitable audition d'orgues au tabernacle des Mormons, la caravane internationale se remet en route pour la Californie, dans une direction sud-ouest, par voie du chemin de fer Union Pacific.

Ceci est un moyen autrement commode de franchir les immenses espaces désolés qui nous restent à parcourir avant d'atteindre la côte du Pacifique, que celui dont disposaient les courageux colons qui vinrent s'établir dans la région du Grand Bassin vers le milieu du siècle passé. La majeure partie du trajet qui reste à faire dans l'Utah s'effectue sur les terrasses alluvionnaires de l'ancien lac Bonneville (nom donné en l'honneur du capitaine Bonneville, explorateur qui fut le premier à expliquer l'existence du grand lac éteint).

Par la vallée de la Muddy River, qui représente un type de vallée désertique, le train pénètre dans l'état de Névada, où nous trouvons le désert américain dans sa forme la plus accomplie, s'étendant sur toute la largeur de cet état pour se continuer sans interruption à travers le sud de la Californie. La région désolée que traverse l'Union Pacific Railway et qui occupe une surface de plus de 10,000 kilomètres carrés est connue sous le nom de désert de Mohave.

Pendant plus de 24 heures, ce ne fut qu'une succession de rochers nus, de chaos de galets et de graviers charriés et déposés par les torrents dévalant des montagnes; car il faut observer que si la pluie est bien rare dans ce pays aride, elle peut tomber parfois en abondance et exercer alors une action érosive extraordinaire sur tous ces matériaux rocheux que l'absence de végétation rend sans consistance. Le tout alterne avec des plaines de sables brûlants, ne portant que quelques touffes d'artémisia odorante (*sage brush*) plante la plus persistante de ces régions arides où nous trouvons parfois aussi des étendues de forêts de plantes grasses, comportant principalement des yuccas et des cactus géants dont les ramifications en forme de candélabre sont d'un effet plutôt bizarre dans le paysage.

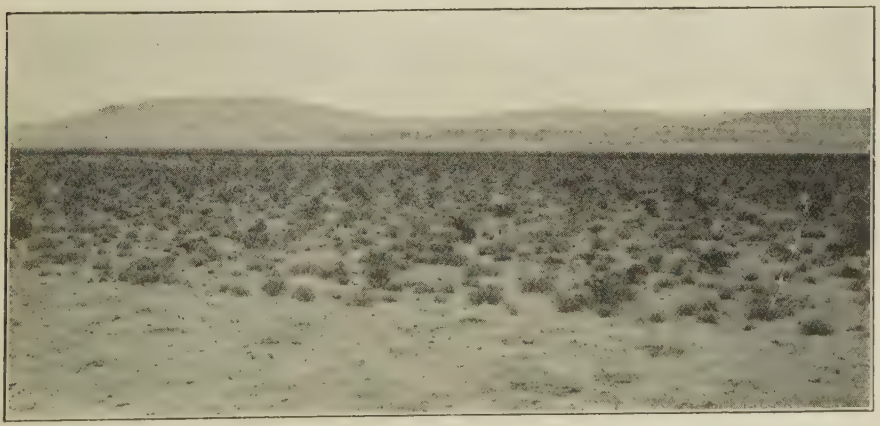
Dans la chaleur de l'après-midi, il arrive aussi que le vent se lève sur ces espaces grillés par le soleil; au loin on voit surgir des nuées jaunâtres qui se rapprochent en tourbillonnant, et malgré que nous respirions à peine

par une température dépassant 110° Farn., la fermeture des chassis des wagons s'impose pour trouver protection contre l'atmosphère de sable brûlant qui pénétre par toutes les ouvertures. Pendant que train continue à nous emporter sans arrêt, on songe avec quelque commisération aux pionniers des temps jadis, obligés de traverser ces espaces redoutables, dépourvus de routes, avec leurs attelages de boeufs, exposés dix fois à périr de chaleur et de soif, au milieu d'une tempête de sable, avant d'avoir atteint leur but.

Trop significatif à cet égard est le nom de Vallée de la mort qui fut donné à l'un des passages empruntés communément par les convois de chars à boeufs qui se rendaient de Salt Lake City dans le sud de la Californie. Des caravanes entières y périrent lors des mouvements de migration qui eurent lieu vers le milieu du siècle dernier. On se rend compte aussi des souffrances et des privations qu'endurèrent les ouvriers employés à la construction de cette voie de chemin de fer à travers des régions aussi inhospitalières.

Parfois cependant, nous rencontrons un oasis, comme perdu dans cette immensité stérile, telle cette petite localité de Las Végas, d'une consonnance bien espagnole, située non loin de la frontière entre l'état de Névada et celui de Californie, où le train fait arrêt pour permettre l'examen de quelques profils de sols typiques de cette grande zone désertique. Dans la vallée de Las Végas, où la précipitation atmosphérique annuelle n'atteint qu'une moyenne de 4.8 de pouces, c'est encore une fois l'eau provenant d'une petite rivière et de puits artésiens qui a converti en plantureux champs de luzerne ou en productifs vergers de pêchers et d'abricoltiers, des espaces de terrains calcinés dont la teneur en alcalis est ordinairement le principal obstacle à vaincre dans la mise en culture.

Pour quitter la région du Grand Bassin, notre train spécial franchit la chaine des montagnes de San Bernardino qui sépare le désert de Mohave du bassin du sud de la Californie, par le Cayan Pas. De là nous descendons rapidement dans ce pays où les réminiscences de la domination espagnole ajoutent partout la note romantique qui fait trop généralement défaut dans les autres parties des Etats-Unis. Des noms tels que San Gabriel, San



Aspect des sols désertiques du Névada.

Fernando, Santa Barbara, Ventura, San Miguel, etc., rappellent d'anciennes missions franciscaines, autrefois si florissantes, mais que des lois spoliatrices, édictées vers 1838, lorsque ce territoire faisait encore partie du Mexique, ont précipité dans la décadence et la ruine.

Aujourd'hui encore, les temples et édifices conventuels, d'un style spécial à la région, désigné populairement sous le nom d'"architecture de mission," composite de styles espagnol, mauresque et gréco-romain témoignent de la belle oeuvre de civilisation accomplie jadis par les moines espagnols parmi la population indienne. La plupart de ces constructions sont actuellement en ruines, ayant subi tous les outrages d'un vandalisme barbare après la dispersion de ceux qui les édifièrent et en assurèrent le développement par leur labeur incessant. Quelques unes cependant furent restaurées ou ont servi d'inspiratioon à des constructions nouvelles, telle cette charmante hôtellerie de la petite ville de Riverside, portant l'enseigne de "Mission-Inn," véritable musée qui n'est qu'une reproduction fidèle d'un ancien monastère de la période espagnole, avec son préau intérieur entouré de galeries à arcades, planté de palmiers et de fleurs, où il ne manquait qu'un verre de vin pour se croire transporté à Séville, durant le diner qu'y offrit aux congressistes la Chambre de commerce de l'endroit.

Nous trouvons une autre tradition de ces temps où le mysticisme l'emportait sur les préoccupations uniquement matérielles, dans les représentations de la Passion qui se donnent encore chaque année, durant la Semaine sainte, aux abords du grand calvaire érigé sur le mont Rubidoux, piton de rugueux granit qui domine l'élégante ville des orangeries et ses pittoresques environs. C'est là que nous fimes arrêt d'une journée. Ville récente, de 32,000 habitants, toute sillonnée de magnifiques avenues plantées de palmiers et bordées de superbes résidences, Riverside doit sa prospérité aux immenses vergers irrigués, d'orangers, citronniers, noyers, abricotiers, etc., dont elle est le centre. Elle jouit aussi de l'honneur d'être le lieu de naissance de la fameuse orange sans pépins, dont la multiplication fut un évènement capital pour les producteurs de fruits de la Californie. Enfin, cette ville de l'arbre chanté par Mignon est aussi le siège de la station expérimentale, de l'état de Californie, pour la culture des orangers (Citrus experiment station), qui dispose, pour ses expériences, d'une étendue de plus de 700 acres de vergers irrigués. Si l'on sait qu'un tel verger, arrivé à l'âge de production normale, vaut de 4000 à 5000 dollars l'acre, on pourra se faire une idée de la valeur foncière que représentent les surfaces mises en culture grâce à l'irrigation autour de Riverside.

De ce centre des orangeries, le convoi nous amena à Los Angeles, située à 60 milles à l'Ouest, ville champignon comptant actuellement un million d'habitants qui ne répond nullement aux promesses qu'éveille son nom enchanteur, ni à la réputation que lui donne Hollywood. Au lieu d'une espèce d'Eden qu'on s'imagine volontiers, ce lieu des ébats des étoiles de cinéma produit plutôt l'impression d'une grande foire en état continuel de démolition et de reconstruction. Entre Los Angeles et sa plage de Long Beach, les innombrables pylones surmontant les puits à pétrole forés dans cette région, font, de loin, l'effet, d'une forêt de sapins.

En quittant Los Angeles par le chemin de fer Southern Pacific, pour suivre une direction nord, nous nous engageames dans la région physiographique à laquelle on a donné le nom de Vallée Centrale de Californie (Central Valley of California), sorte de plaine s'étendant sur une longueur de près de 500 milles, du sud au nord, et d'une largeur moyenne de 40 milles seulement, formant donc comme une immense auge comprise entre la chaine des Montagnes cotières (*Coast Range*) à l'ouest et la Sierra Nevada, qui atteint une altitude notablement plus élevée, à l'est.

Le drainage de cette région s'opère en deux sens opposés, sud-nord par la rivière San Joaquin et nord-sud par la rivière Sacramento, les deux cours d'eau se jetant dans l'Océan Pacifique, à peu près à mi-chemin entre les extrémités, par une brêche faite dans la chaine côtière, correspondant à la baie de San Francisco.

Il en résulte que la partie sud de la Grande vallée de Californie prend le nom de vallée de San Joaquin et la partie nord celui de vallée de Sacramento.

Le tronçon méridional de la vallée de San Joaquin, que l'on parcourt sur une distance de près de 200 milles jusqu'à Fresno, est soumis à des conditions climatiques arides, puisque la précipitation annuelle moyenne n'y atteint pas 10 pouces. Il est donc impossible aussi d'y pratiquer de la culture sans irrigation. Presque tous les affluents du cours d'eau principal viennent de l'est, où ils s'alimentent sur les versants de la Sierra Nevada, montagnes beaucoup plus hautes que celles de la Chaine côtière et recevant donc une précipitation d'eau plus abondante. Aussi est-ce eux qui fournissent l'eau d'irrigation indispensable à la culture intensive qui, aux environs de Fresno, porte principalement sur la vigne.

Au nord de Fresno, la chute d'eau annuelle augmente graduellement pour atteindre 30 pouces à l'extrémité de la vallée.

Examen d'un profil de sol rouge à Athens (Géorgie).

Après une rapide visite à San Francisco et avoir admiré la splendeur de la grande baie entourée des hautes falaises qui s'ouvre sur l'Océan par la Porte d'Or (Golden Gate), on se rendit à l'Université de Berkeley, avec son magnifique collège d'agriculture, assise comme une reine sur le versant de la montagne qui fait face à la mer. Le Hilgard Hall y rappelle la mémoire d'un des grands pionniers de la Science du sol en Amérique.

De Berkeley, le train d'excursion continua vers le nord, après transbordement, par traversier, de l'autre côté de l'estuaire de la rivière San Joaquin, pour s'engager ensuite dans le deuxième tronçon de la Grande vallée de Californie, en remontant le cours de la rivière Sacramento qui l'arrose. La région de la Grande Vallée finit là où la rivière Sacramento coule dans une gorge étroite, et le chemin de fer, après avoir suivi celle-ci sur une certaine distance, l'abandonne pour passer au pied du mont Shasta, l'un des plus hauts pics volcaniques de l'Amérique du nord, dont la cime neigeuse se dresse à près de 14,500 pieds d'altitude et domine à l'est les champs de lave qui vont rejoindre le grand plateau basaltique de l'Orégon.

Le mont Shasta se trouve juste au point où la grande chaine de montagnes de l'est, la Sierra Nevada, changeant de direction, prend le nom de Chaine Cascade et constitue alors le bord disloqué et relevé du grand plateau basaltique qui couvre une surface de 200 000 milles carrés, sur une épaisseur d'une couple de milliers de pieds, dans les états d'Orégon, Idaho et Washington.

Continuant toute la nuit sa course ininterrompue, notre convoi pénètre dans l'état d'Orégon pour n'arrêter que le lendemain, vers midi, à Corvallis, siège de l'Université et du collège d'agriculture de l'état, après une étape de 700 milles depuis Berkeley.

Dans cette chaîne des Cascades, qui doit son nom aux chûtes que forme la rivière Columbia en la franchissant par une grande brèche pour se jeter dans la mer, à 80 milles de la ville de Portland, se dressent encore d'autres géants volcaniques, tels que les monts Rainier et Baker, dont les cratères, à défaut de laves, rejettent parfois encore des pluies de cendres.

Au jour, il suffit de jeter un coup d'oeil par le chassis du wagon pour constater que les conditions climatiques ont de nouveau entièrement changé depuis la vallée de Californie. Les conifères gigantesques qui couvrent les flancs des montagnes et nous accompagneront maintenant vers de nord et dans notre retour vers l'est, jusqu'à travers la Colombie britannique, démontrent assez qu'un climat tempéré joint à d'abondantes chûtes d'eau annuelles a remplacé le climat chaud et sec qui prédomine dans la vallée de Californie. De l'Orégon, pays charmant, qui aux belles perspectives de montagnes joint aussi des plaines de sols fertiles, nous retiendrons surtout les fameuses cerises, grosses comme des prunes et d'une saveur sans égale, dont on nous régala sur le campus de l'université de Corvallis. Cet état jouit d'ailleurs d'un climat vraiment idéal: chaleur tempérée en été, pratiquement pas d'hiver, végétation luxuriante avec beaucoup de fleurs; aussi lui donnerait-on de beaucoup la préférence au sud de Californie s'il s'agissait de choisir entre les deux comme résidence.

Depuis assez longtemps déjà, nous parcourons la vallée de la Willamette, rivière qui s'écoule vers le nord, dans une région déprimé entre la

chaîne des monts Cascades et les hauteurs bordant la mer, assez semblable à la Grande vallée de Californie. De Corvallis le chemin de fer continue à la descendre jusqu'à Portland, la ville des roses, où il franchit la grande rivière Columbia, ensuite nous entrons dans l'état de Washington pour arrêter à Seattle, important port situé sur le bras de mer qui s'enfonce profondément à l'intérieur des terres. Tout le long de ce trajet, on remarque l'importance qu'a l'industrie du bois pour cette région, aux nombreuses et grandes scieries qui se succèdent. Les prodigieux troncs d'arbres qu'on y voit débiter donnent une idée de la richesse en matériel ligneux du pays.

Le 11 juillet, au matin, le train spécial des amateurs du sol, que l'on a pris à Seattle pour une bande de mineurs venant de la Californie, franchit la frontière internationale, sous l'oeil bénévole des autorités canadiennes qui les laissent passer de confiance, sans autre formalité et nous voilà à Vancouver, rencontrant le premier jour de pluie depuis le départ de Washington. Le temps couvert empêche de faire ressortir à leur juste valeur les beautés du paysage qui encadre l'active métropole commerciale de la côte Pacifique du Canada. A partir de Vancouver, c'est le retour vers l'est, qui commence par voie du chemin de fer National Canadien, que l'on est fier de retrouver après l'essai de la douzaine de compagnies ferroviaires américaines. D'une seule traite, nous accomplissons le trajet de 535 milles qui sépare la côte du Pacifique, en Colombie Britannique, de Jasper Park, Alberta, traversant le Plateau intérieur de la Cordillère en empruntant les gorges encaissées et sauvages du Fraser et de son affluent, la rivière Thompson, pour franchir ensuite la crête des Rocheuses proprement dites et redescendre sur le versant Atlantique par la vallée de l'Athabaska.

L'arrêt d'une journée à Jaspar Park, dans cet admirable cirque entouré de montagnes couronnées de champs de neige et de glaciers, où les

Un aspect du sud de la Californie

aménagements à la fois confortables, discrets et rustiques du chemin de fer National canadien n'ont rien gâté de la grandiose nature, est fort apprécié de tous les congressistes. D'enthousiastes et exubérants délégués italiens éprouvent même le besoin de venir me donner la main pour me féliciter de la beauté des paysages du Canada qui se sont déroulés depuis hier, beauté qui dépasse à leur avis tout ce que nous avons vu jusqu'ici au cours de la grande randonnée à travers l'Amérique.

Bientôt nous avons de nouveau perdu de vue les hautes montagnes aux flancs déchirés desquels on distingue si nettement les plans de stratification restés presque horizontaux, ou seulement faiblement inclinés, au cours d'un mouvement de surrection de plusieurs milliers de pieds, comme si les forces titanesques entrées en jeu dans ce travail prodigieux n'avaient pas dévié de la verticale. Nous traversons la haute plaine de l'Alberta pour arrêter à Edmonton où nous visitons le collège d'agriculture et les premiers profils de sols de la Plaine canadienne. Continuant la course vers l'est, le train spécial fait aussi arrêt à Saskatoon, dans la Saskatchewan, dont on admire la jolie université bâtie en style gothique anglais et sa pépinière forestière; puis il nous mène à Winnipeg, avec visite, en cours de route, des fermes expérimentales fédérales d'Indian Head (Saskatchewan) et Brandon (Manitoba).

A Winnipeg, nous sommes dans la cuvette de l'ancien lac glacaire Agassiz, ce qui fournit l'occasion d'examiner les profils des fameux limons humifères de la vallée de la Rivière Rouge, que nous remontons ensuite pour rentrer dans les Etats-Unis, où le premier arrêt est pour Fargo, North Dakota, siège du collège d'agriculture de cet état. Cette région du Dakota se trouve toujours dans le prolongement de la riche plaine d'alluvions déposées dans le grand lac glaciaire qui couvrit de ses eaux une superficie de 110,000 mille carrés, s'étendant des deux côtés de la frontière actuelle entre l'Union américaine et le Canada.

L'excursion organisée par le collège d'agriculture de Fargo, le 16 juillet, fut des plus intéressantes parce qu'elle fit voir toute la succession des alluvions du célèbre bassin lacustre, depuis l'argile lourde déposée sur le fond, jusqu'aux graviers des deltas et terrasses de la périphérie où on passe, sans transition au drift glaciaire non remanié.

Après Fargo, la première station fut pour St-Paul et Minnéapolis, les deux villes jumelles du Minnesota, que sépare le Mississipi rencontré pour la deuxième fois.

La journée du 17 juillet se passe à la visite de la grande université de Minnéapolis et des parcelles d'expérimences de son collège d'agriculture. Nous pouvons aussi admirer les magnifiques quartiers résidentiels et parcs aménagés avec beaucoup de goût autour de la ville qui doit son imporatnce principalement aux grandes minoteries qui reçoivent les blés du "Middle West". Des lacs glaciaires, entourés de collines morainiques qui caractérisent la topographie de la région, se prêtent d'ailleurs admirablement à l'aménagement de ces parcs et boulevards où la population trouve des promenades et des terrains de jeu des plus variés.

De l'état de Minnesota nous passons ensuite dans celui d'Iowa, où il nous est donné de visiter le collège d'Ames, lequel est certainement un des plus beaux que possèdent les Etats-Unis. Puis c'est l'Illinois, où le Mississipi est traversé pour la troisième fois, à Moline, ville qui se distingue par ses grandes usines de machines aratoires, dont quelques-unes sont visitées, notamment celles de John Deere et Co.

Enfin, le matin du 20 juillet, tout le groupe des spécialistes en sols débarque au beau milieu des grands abattoirs de la maison Swift, à Chicago, où on leur fait voir dans tous les détails ce que deviennent les troupeaux d'animaux élevés sur les grandes étendues de sols des états du "Middle West," qu'on y amène continuellement.

Après une visite aux grandes usines de l'International Harvester Company, qui fabriquent en séries ces puissants tracteurs destinés à déchirer en tous sens les sols qu'on a étudiés, nous quittons l'Illinois pour l'Indiana où l'université Purdue, à Lafayette, sera notre dernière station, qui se termine par l'examen d'un profil de Missouri silt loam, avant de reprendre le chemin de Washington.

Nous revenons à notre point de départ, le 22 juillet, au soir, franchissant d'une traite la distance de près de 900 milles qui sépare Lafayette de la capitale fédérale, en passant par Indianapolis et Cincinnati.

L'Hospitalite Americaine

Plus d'un congressiste, j'en suis sûr, devait de demander, non sans quelque appréhension, le soir de l'embarquement à bord du train d'excursion, au départ de Washington, quel serait l'emploi du temps entre les opérations de "soil examination" figurant officiellement au programme des différents points d'arrêt du parcours. La réception faite dès le premier arrêt, le lendemain matin, à Greensboro, coquette ville de la Caroline du Nord, possédant la plus grande manufacture de cotonnades du continent, devait dissiper toute inquiétude à cet égard.

Une soixantaine d'automobiles mobilisées par la chambre de commerce de l'endroit, chacune portant son numéro et conduite par le propriétaire, attendaient les excursionnistes à la descente du train.

Il ne s'agissait que de faire son choix parmi les obligeants chauffeurs volontaires appartenant à toutes les professions rattachées à la chambre de commerce de l'endroit et, aussitôt tout le monde embarqué, le cortège se mit en marche sur ces belles routes américaines que l'on retrouve à peu près uniformes d'un océan à l'autre, construites généralement en béton et divisées par le milieu, au moyen d'un ruban blanc, de trois ou quatre pouces de largeur, afin de nettement délimiter le trafic dans chaque sens.

Après la visite aux profils de sols typiques de la région, on nous mena auo *country club* de la chambre de commerce, situé sous de frais ombrages, au bord d'un lac minuscule, où furent servis un lunch copieux et des rafraichissements variés, lesquels ne manquèrent pas d'être fort appréciés par les excursionnistes que la chaude température de fin Juin rendait très altérés.

Puis ce furent les traditionnels discours de bienvenue des autorités suivis des réponses et remerciements par des notabilités du congrès, et réintégration des automobiles. L'après-midi, nos amphytrions nous firent les honneurs

de tout ce qu'on pouvait voir de remarquable aux alentours de leur ville, jolis quartiers résidentiels, avec villas et cottages allant du modeste au somptueux, mais presque toujours construits avec goût au milieu de ces jardins où les anglo-saxons savent si bien marquer leur prédilection pour les arbres et les fleurs.

Puis ce fut la visite à des lieux historiques de la région, parcs avec monuments érigés à la mémoire de la guerre de Sécession, dont plusieurs épisodes importants eurent comme théâtre les environs de Greenboro.

Le soir, un grand banquet réunissait les congressistes et les notabilités de l'endroit au principal hôtel de la ville, et l'hécatombe de poulets inaugurée dès le déjeuner de midi, au *country* club, reprenait de plus belle; elle ne devait d'ailleurs plus cesser de précéder le convoi international, comme une traînée meurtrière pour la gent gallinacée, dans tout son itinéraire à travers l'Amérique.

L'accueil fait au participants du congrès international de la science du sol se répéta partout où ils s'arrêtèrent dans les divers états de la grande république et dans les provinces du Canada traversées en train spécial. A chaque endroit, la chambre de commerce prévenue, comme à Greenboro, ou le personnel des universités et collèges d'agriculture, là où ces institutions existaient, avaient organisé tout un programme de réception pour faire passer le temps d'une manière aussi agréable qu'utile aux visiteurs étrangers. Ce fut avec une complaisance et une bonne grâce charmante que les membres des chambres de commerce, professeurs des universités et collèges d'agriculture, experts et démonstrateurs des stations expérimentales sacrifièrent des journées entières au bénéfice de leurs hôtes, leur rendant le séjour aussi agréable qu'instructif. Chacun se plut aussi à admirer ce esprit de solidarité qui anime les citoyens des nombreuses villes américaines en pleine voie de développement, dont hier on ignorait presque le nom. On voit que tous s'efforcent à faire connaître et faire valoir au dehors leur ville, dans le but de créer des relations qui puissent, de façon directe ou indirecte, favoriser son essor commercial et industriel. L'infidèle mémoire n'a pu, évidemment, conserver le souvenir de chacun de ces guides d'un jour qui nous obligèrent beaucoup et ne reçurent en échange qu'un merci et une cordiale poignée de main, mais je n'oublierai jamais la silhouette de ce cultivateur, vétéran de la guerre de Sécession, qui nous prit dans son auto, à la Crosse, Kansas. Ce brave qui avait vu passer 85 hivers et perdit un bras sur le champs de bataille, il y a quelques 65 années, se tenait encore droit comme un grenadier au port d'arme et manjait le volant avec une fermeté et une assurance qu'aurait pu lui envier plus d'un jeune homme de vingt ans.

Voilà certes une puissante réclame en faveur de la salubrité de la profession de *farmer* dans les prairies du *Middle-West*. Il nous resterait maintenant à discuter les principes qui ont servi à la classification des profils de sols étudiés dans la grande excursion transcontinentale.

Ceci pourra faire l'objet d'un autre article intitulé: "Le Facteur climat dans la genèse et la classification des Sols."

ACTIVITES DES SECTIONS.

Section de Montreal.

Le premier dîner-causerie de la Section de Montréal, pour l'année courante, a eu lieu au cercle université de cette ville, le samedi 20 Octobre dernier.

Monsieur Olivar Asselin, Directeur du Comptoir des Obligations de la Maison de Banque L. G. Beaubien, Limitée, fut l'hôte d'honneur et le conférencier du jour.

Présenté par M. H. M. Nagant, président de la Section, monsieur Asselin traita d'un sujet particulièrement pratique pour des agronomes de district, qui sont maintes fois dans l'occasion de devoir donner un conseil relativement à des placements à faire, aux cultivateurs avec lesquels ils sont en relations et qui ont mis leur confiance en eux.

Il fit un exposé des dispositions légales qui régissent l'émission des emprunts obligatoires au Canada. Au cours de cet exposé, le conférencier insista surtout sur l'importance qu'il y avait pour tout épargnant de ne placer son argent que dans des obligations émises avec tous les facteurs de garantie que l'on est en droit d'exiger.

Il faut en conclure que la première précaution à prendre, lorsqu'on veut placer de l'argent en obligations, est de ne s'adresser qu'à des maisons très sérieuses, qui ne consentent à vendre que des titres dont elles ont, au préalable, soigneusement vérifié toutes les conditions sauvegardant l'intérêt de l'emprunteur.

Monsieur Gonzague Pelletier, Agronome officiel de Huntingdon, se fit l'interprète de l'assistance pour remercier monsieur Olivar Asselin de son intéressante et utile causerie.

CONCERNING THE C.S.T.A.

A meeting of the Society's Executive Council, with Dr. E. S. Archibald presiding, was held in Toronto on November 23rd. It afforded an opportunity for discussing several important matters and reviewing the Society's present mid-year position. A summary of the meeting follows:—

(1) The successful candidates for the T. Eaton Company scholarships for 1928 are now pursuing their graduate studies—four under the Graduate School of the University of Toronto and one at McGill University. The five 1929 scholarships are to be advertised immediately in *Scientific Agriculture,* and applications received up to May 15, 1929.

(2) Grants to assist in publishing the current volume of *Scientific Agriculture* amounted to $4000.00, a slight increase over the previous year. The extra revenue was being used to provide a better quality of paper and to increase the size of the journal slightly.

(3) The total number of regular members was 1,001 as compared with 989 on June 1st, 1928. The names of 49 members have been removed during the past six months and 61 new members have been admitted in the same period.

(4) Finances are in excellent shape. On November 1st the Society had a cash credit balance of $2,698.93 as compared with $2,515.61 on June 1st, 1928 and with $1,806.81 on the same date last year. There has been a most encouraging increase in advertising revenue during the past few months.

(5) A suggestion that the Society should adopt some form of group insurance for its members was rejected for the time being, on the ground that the benefits were not equal to the amount of clerical work involved.

(6) Dates for the Ninth Annual Convention at Winnipeg, were tentatively set for June 12th to 15th inclusive, 1929. Consideration was also given to the Convention programme.

(7) The matter of providing more adequate headquarters for the Society at Ottawa was discussed fully. There is some possibility that a solution to this difficulty may be found at an early date, in which case further announcement will be made in these pages.

(8) It was decided to proceed at once with the organization of an Economics Group within the C.S.T.A., to include all members interested in Economics, Farm Management and Marketing. A Dominion-wide organizing committee was appointed as follows:—J. E. Lattimer, chairman; W. V. Longley, C. Gagné, W. H. J. Tisdale, F. C. Hart, J. Coke, A. Cairns, H. C. Grant, P. H. Ferguson, H. S. Fry, Wm. Allen, D. A. MacGibbon, H. R. Hare, A. E. Richards, F. M. Clement, G. E. McIntosh and L. C. McOuat.

Notes and News

W. C. Wood (Saskatchewan '26), who has been Assistant in Agricultural Engineering at the University of Saskatchewan for the past two years, has joined the Experimental and Extension Department of the Massey-Harris Co., Ltd., Toronto, Ont.

W. A. Weir, Secretary of the Western Ontario local of the C.S.T.A., has changed his address to 5 Defries Street, Toronto 2, Ont.

G. H. Bowen (McGill '23) is taking a course in landscape design and associated subjects at Columbia University. His address is 10 Fifth Avenue, New Rochelle, N.Y., U.S.A.

E. C. Beck (Toronto '28) has been appointed Assistant Bacteriologist in the Department of Public Health, Toronto, Ont. His mailing address is 87 Petman Avenue, Toronto 12, Ont.

J. H. Bredin (Saskatchewan '22) is spending the winter months taking a course in economics at Columbia University. His address is Butler Hall, 88 Morningside Drive, New York City, U.S.A.

Arthur Dumais (Laval '17) has changed his address to P. O. Box 782, Saskatoon, Sask.

F. C. Hart (Toronto '06) who has been Director of the Co-operation and Markets Branch of the Ontario Department of Agriculture since 1914, has been appointed Professor of Rural Economics at the Ontario Agricultural College, Guelph, Ont.

A. Fraser Ross (Toronto '22) has changed his address to 3623 Lorne Crescent, Montreal, P.Q.

G. V. Van Tausk (New Zealand '99), who has been Specialist in Agriculture at the Victoria High School, Victoria, B.C., for the past two years is now teaching at the Collegiate Institute, Perth, Ont.

G. G. Moe (McGill '14) has resumed his duties as Associate Professor of Agronomy at the University of British Columbia. He has been on leave of absence for several months taking graduate work at Cornell University and has been awarded the degree of Ph.D. by that institution.

G. G. Dustan (Toronto '27) has changed his address to 2118 Hendon Avenue, St. Paul, Minn., U.S.A., presumably to take graduate work at the University of Minnesota.

A. L. Hay (McGill '21) has been appointed Herdsman for the Consolidated Mining & Smelting Company of Trail, B.C., at their Marysville, B.C., farm.

H. N. Racicot (McMaster '21) has obtained leave of absence from the Dominion Laboratory of Plant Pathology, Ste. Anne de la Pocatière, P.Q., and is taking graduate work towards a Ph.D. degree in the Department of Botany, University of Toronto, Toronto, Ont.

B. Leslie Emslie (West of Scotland Agricultural College '03) has resigned as Canadian Director of the Chilean Nitrate Committee and has been appointed General Manager of the Chemicals and Dyes Department of Canadian Industries Limited, with headquarters at Montreal, P.Q. D. C. McArthur (Toronto '21) has been appointed to the position vacated by Mr. Emslie, and will take up his duties on December 1st. The offices of the Chilean Nitrate Committee are located at 217 Bay Street, Toronto 2, Ont.

J. E. Edgar (Alberta '27) is teaching science at the School of Agriculture, Vermilion, Alberta. He was formerly mathematics and science teacher at the High School, Fort Saskatchewan, Alta.

M. A. Watt (Toronto '25) has changed his address to P. O. Box 111, Almonte, Ontario.

G. H. Harris (British Columbia '22) who has been completing graduate work towards a Ph.D. degree at the University of California, has resumed

his duties as Assistant Professor of Horticulture at the University of British Columbia, Vancouver, B.C.

E. A. Howrie (Saskatchewan '23) has changed his address from Prince Albert, Sask., to Tugaske, Sask.

D. W. Thompson (British Columbia '26) has returned to British Columbia from Ottawa, where he has been Seed Inspector with the Dominion Seed Branch, and is now located at the Dominion Seed Branch, 418 Winch Building, Vancouver, B.C.

Armand Joubert (Laval '24) has been transferred from Macamic, P.Q., and is now County Agriculturist at St. Georges East, County Beauce, P.Q.

C. A. Zavitz (Toronto '88) is spending the winter months in Florida. His address is Apt. 10, Court Park, Second Avenue North, St. Petersburg, Florida.

Applications for Membership

The following applications for regular membership have been received since November 1, 1928:—

Aamodt, O. S. (Minn. 1917, B.S.; 1922 M.S.; 1927 Ph.D.) Edmonton, Alta.
Drummond, N. A. (McGill, 1928, B.S.A.), Guelph, Ont.
Emslie, A. R. G. (Toronto, 1928, B.S.A.), Guelph, Ont.
English, R. A. (Alberta, 1928, B.S.A.), Fleet, Alta.
Graham, A. R. (McGill, 1923, B.S.A.; 1926 M.Sc.), Chatham, Ont.
Hannam, H. H. (Toronto, 1926, B.S.A.), Toronto, Ont.
Kelley, C. C. (Alberta, 1925, B.S.A.), Williams Lake, B.C.
Mather, T. H. (Alberta, 1922, B.S.A., M.Sc. 1925; Minn., Ph.D. 1928), Edmonton, Alta.
Moffatt, K. F. (British Columbia, 1928, B.S.A.), Victoria, B.C.
McFarlane, A. S. (McGill, 1928, B.S.A.), Macdonald College, P.Q.
Raithby, G. E. (Toronto, 1922, B.S.A.), Guelph, Ont.
Rioux, Albert (Laval, 1927, B.S.A.), Sayabec, P.Q.
Ruhnke, G. N. (Toronto, 1923, B.S.A.), Guelph, Ont.
Scholes, J. C. (Manitoba, 1928, B.S.A.), Winnipeg, Man.
Steenburg, W. E. (Toronto, 1927, M.A.), Chatham, Ont.
Stuckey, R. W (McGill, 1928, B.S.A.), Crowborough, England.
Syrotuck, M. (Alberta, 1927, B.S.A.), Calgary, Alta.

Activities of Locals

One of the greatest problems of the Society has been to maintain the necessary activity among its local branches. Local executives have felt that the interest of individual members would be much greater if each local was given specific work to do, in which every member could take an interest and play a part.

Dr. Archibald, President of the Society, has discussed this situation with the General Secretary on several occasions, and has expressed the opinion that the work of the Society's standing committees offers a field for useful collaboration to every member and to every local branch. He has therefore written to each local secretary, under date of November 26th, the following letter:—

Dear ————————,

I fully realize that some of the locals have done considerable work in assisting our standing committees to gather data. They have also obtained the opinion of members on various subjects and some locals have taken steps toward the active adoption, within their territory, of the valuable recommendations made by standing committees. Nevertheless, I feel it is urgent that each local during the winter should show considerable energy and devote some time to a thorough review of some of our major agricultural problems, at least as represented by each of our standing committees. Might I be permitted to offer the following thoughts which occur to me in this connection:—

1. Affiliations and Group Organization.

This field of work is practically unlimited. Is there any reason why it should not be most advantageous, in fact urgent, that we have active groups within our Society and sub-groups in most of our locals in almost every one of the various divisions of scientific agriculture? If not, at least should we not have the greatest affiliation between our Society and such groups of men?

Mr. L. H. Newman is, as you know, Chairman of this standing committee. It is probable that he will write to you along these lines, but in any case I know that he would appreciate the careful consideration and recommendations of your local.

2. Educational Policies

Would it not be well to have some member or small committee in your local again review the excellent report of Dr. Klinck's committee, 1926, and Dr. Klinck's personal report of 1927, and present to your local meeting views for discussion and recommendations. Copies of these reports can be obtained from the General Secretary.

Surely there might be recommendations from your local re:

(a) Further immediate work of this Committee;

(b) The applicability or non-applicability of these reports to your province or territory;

(c) Lines of work for each local to undertake in order to induce universities and departments to expend their energies along these and similar lines.

Dr. Klinck is still Chairman of this Committee and I know he would appreciate such action and recommendations from each local.

3. Graduate Studies

Although this subject is of interest to less than half of our members, would it not be advisable to give this problem exactly the same treatment as that of educational policies? Dr. G. G. Moe, who was Chairman of this standing committee, presented two very able reports in 1925 and 1926 and although this committee was not reconstituted in 1927 or 1928, it no doubt will have further duties; hence, recommendations from each local are urgently needed. Moreover, as you know, the C.S.T.A. was able to obtain special funds for a survey of graduate facilities in Canada. Dr. Robert Newton has consented to undertake this work and your Executive asks from each local the most active support and assistance to Dr. Newton in this most important work.

4. Research.

Perhaps the scope of work of this Committee has been either circumscribed or ill-defined. This is one of the oldest committees and the early work undertaken was fundamental, namely that of a thorough survey of research work under way in all the agricultural institutions of Canada. However, it appears to me that there might have been broader development of work in this committee in more recent years.

Cannot the C.S.T.A., through the work of this Committee, more closely co-ordinate research men, Federal and Provincial, in each Province and group of Provinces, and cannot they also stimulate group organization amongst research men? Should not each local carefully survey this subject and suggest means of stimulating research as well as compile a list of the urgent agricultural problems requiring research in each district, and contribute these as suggestions to the standing committee?

Why should not each member actively express his best judgment on this problem of agricultural research? Can we as a Society show any indifference

by leaving to isolated research workers, or small groups thereof, or departments of agriculture, or universities, or the National Research Council, the work of surveying the field and suggesting initial activity? After all, the C.S.T.A. members are the men who eventually will do the work. Why then should not our greatest energies be expended in surveying the field and assisting these bodies in initiating work and in the organization thereof?

I know that Dr. G. P. McRostie, the Chairman of this committee, will no doubt be in touch with your local and I am sure will appreciate the fullest possible recommendations.

5. Marketing Education

This committee has presented several useful reports, 1925-1926-1928, on this subject. There is no doubt that this is one of the important problems in our agricultural development of the future. Does not your local feel that we have now reached the point when an active group in agricultural economics and farm management should take up active work in this and allied problems?

You will remember that Dean Clement, Chairman of this committee, in presenting his last report, strongly urged such an organization. I feel sure that your careful discussion of this problem and recommendations from your local would be much appreciated by Dean Clement.

6. Co-ordination of Agricultural Policies.

Dean Howes, Chairman of this committee, has presented two very able reports on this subject, the one of 1927 surveying the field, and his last report reviewing different opinions on this subject. In his 1929 report, he anticipates more definite recommendations, and he has already intimated that he will ask your local to give considerable time and fullest possible recommendations on this subject. Whether or not we are salaried technical men or independent agriculturists, we are all taxpayers, and we should be, and no doubt are, intensely interested in this problem. Each year we hear a fresh outburst of criticism on the subject of overlapping. Each year we as individual workers note misunderstandings and certain friction due to a lack of co-ordination of policies. Fortunately, these become fewer each year. Nevertheless, it does appear as though members of the C.S.T.A. and all locals, have a special duty to perform to scientific agriculture of the future by giving this matter most thoughtful consideration. Dean Howes will certainly appreciate your assistance.

7. Membership Committee.

There are still men, and groups of men, eligible for membership in the C.S.T.A., who are not members. If their indifference is due to lack of personal interest or proper canvassing, should not each local give this most careful consideration and initiate a more active campaign? If, however, these men are not members because in their opinion the C.S.T.A. has not shown activity in channels of interest to them, could you not induce them to express themselves through your local? Your Executive would appreciate fullest recommendations in this regard.

This letter is longer than anticipated, but I trust that you may find time to read it and that, in your opinion, it may be worth while to shoulder upon at least several members of your local the responsibility of reviewing these and other problems, presenting a report with recommendations to your next local meeting and leading in the general discussion thereof. It is hoped that the standing committees and Executive may have your fullest co-operation in this regard.

With kindest personal regards to yourself and all the members of your local, I remain,

Very sincerely yours,

(*Signed*) E. S. ARCHIBALD,
President.